AN INVESTIGATION OF THE RAJIDAE OF THE WEST AND SOUTH COASTS OF SOUTHERN AFRICA

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(With 13 plates, 21 figures and 19 tables)

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Contents

Introduction

This paper represents the results of a three-year survey of the Rajidae of the west and south coasts of southern Africa, and is intended as a paper accompanying that of Wallace (1967) on the batoid fishes of the east coast of southern Africa. All known species of southern African Rajidae have been included in the given key, but, for descriptions of species which are exclusively east coast in distribution, Wallace's (1967) publication should be consulted.

The area originally covered by the survey extends from about Swakopmund on the west coast of South West Africa to Port Elizabeth on the south-east coast of the Republic of South Africa. The majority of the specimens have been obtained by commercial trawlers fishing on the continental shelf between 250 and 900 metres with otter trawls, while the rest have been taken at shallower depths by research vessels. The area of survey has been extended northwards along the west coast to 09°40′S by the examination of material taken by R. V. *Walther Herwig* in 1967. The results of this cruise are given in table 1.

The classification of South African skates is more or less tentative, for members of this difficult family show great variability in their morphological characters, which vary with age and/or sex in the individuals within a species. Furthermore, some of the type specimens of South African rajids, obtained by the Government Marine Survey at the beginning of this century, have been lost, so that it is difficult to verify original descriptions, especially where these are based on juvenile specimens. It is not surprising, therefore, that skate taxonomy has received casual treatment from South African systematists. Recently, however, Wallace (1967) has revised the east coast species, while

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Hulley (1966, 1969) has shown that several species are identical with European species from the corresponding latitudinal belt in the northern hemisphere, and represent cases of bipolar distribution (Ekman, 1953).

Leigh-Sharpe (1920–6) has suggested the formation of pseudo-genera within the Rajidae based on clasper structure, but detailed descriptions of the anatomy of these organs in South African skates and their taxonomic significance above the species level will be published in the near future.

Although precaudal vertebral counts appear to be of greater value for separation of the family above the species level (Ishiyama, 1952), the external and internal structures of the clasper glans are species specific without exception (Ishiyama, 1958, 1967; Hubbs & Ishiyama, 1968) and may be used for comparison of geographically separated species (Hulley, 1966).

Zoogeographical and depth distributional patterns for the species are to be dealt with in a later paper; in the interim period, however, some idea of this may be obtained from the lists of material.

TABLE 1. Rajidae taken by R.V. *Walther Herwig* off the west coast of southern Africa in 1967.

Station No. WH /67	*Position*	*Depth* m	*Species*	*No. of Specimens*
6	09°40′S, 12°58′E	100	*R. miraletus* Linnaeus	6
10	10°28′S, 13°02′E	700	*R. straeleni* Poll	1
12	10°41′S, 13°29′E	100	*R. miraletus* Linnaeus	4
14	11°04′S, 13°30′E	440	*R. miraletus* Linnaeus	2
15	11°30′S, 13°25′E	110	*R. miraletus* Linnaeus	4
17	16°14′S, 11°33′E	100–120	*R. miraletus* Linnaeus	7
18	18°30′S, 11°27′E	310	*R. straeleni* Poll	1
			R. miraletus Linnaeus	2
19	18°35′S, 11°25′E	400	*R. straeleni* Poll	4
20	18°45′S, 11°20′E	500	*R. leopardus* Von Bonde & Swart	2
			R. confundens n.sp.	2
			R. doutrei Cadenat	1
32	20°25′S, 12°02′E	500	*R. leopardus* Von Bonde & Swart	1
			R. confundens n.sp.	1
			R. doutrei Cadenat	1
33	22°03′S, 13°12′E	200	*R. leopardus* Von Bonde & Swart	1
			R. confundens n.sp.	1
			R. straeleni Poll	2
37	22°15′S, 12°46′E	500	*R. leopardus* Von Bonde & Swart	1
			R. confundens n.sp.	1
43	23°00′S, 13°02′E	400	*R. confundens* n.sp.	2
77	30°02′S, 14°39′E	510	*R. confundens* n.sp.	2
			R. caudaspinosa Von Bonde & Swart	1
89	32°06′S, 16°22′E	400	*R. clavata* Linnaeus	1
100	34°12′S, 17°34′E	630	*B. smithii* (Müller & Henle)	1
126	27°13′S, 14°31′E	320	*R. confundens* n.sp.	1
161	26°25′S, 14°18′E	300	*R. clavata* Linnaeus	1
178	32°39′S, 17°25′E	245	*R. clavata* Linnaeus	1
			C. parcomaculata (Von Bonde & Swart)	2
194	33°47′S, 17°14′E	1 000	*R. dissimilis* n.sp.	3
			R. ravidula n.sp.	2
195	33°49′S, 17°13′E	1 000	*R. spinacidermis* Barnard	1
			R. ravidula n.sp.	1
196	33°51′S, 17°14′E	1 350	*R. spinacidermis* Barnard	1
			R. robertsi n.sp.	1

Method

Standard procedures in morphometry have been followed in this paper, and to interpret the variations in the proportional dimensions which take place during growth and which exist between the sexes, as many specimens as possible from each of the species have been examined and measured. As a check against the high intraspecific variability shown by rajids, counts of the number of precaudal vertebrae have been made and, where possible, the morphological structures of the claspers of adult males have been examined. For each species, figures of the external morphology of the clasper glans have been given.

In order to conform with previous work, the scheme of measurement which has been adopted in this paper is that of Bigelow & Schroeder (1953), and is represented diagrammatically in figure 1. Measurements of each specimen have been recorded to the nearest millimetre and have been calculated as permillage (thousandths) of the total length of the specimen. For a given species, the mean of each particular measurement has been calculated and is expressed in tabular form, together with the range of variation of that measurement. In some cases, where few specimens were available, the proportional dimensions of each specimen are given.

It should be noted that Hubbs & Ishiyama (1968) have suggested that the disc width should be used as a basis for computing the proportional sizes of the body parts, since the growth of the tail is negatively allometric (heterogonic) and the tail is frequently damaged. However, this work has shown that a much wider variation for each measurement (except the disc length) is obtained when disc width is used, and the total length has therefore been employed as the basis of calculation in all cases.

There would appear to be differences used in the terminology of the structures of the clasper glans by Leigh-Sharpe (1920–6), by Ishiyama (1958) and by Ishiyama & Hubbs (1968). Stehmann (1969) has evaluated these, and the terminology used in this paper is mainly in accordance with his findings.

Vertebral counts were facilitated by the use of X-ray photography. The number of precaudal vertebrae (Vprd) has been taken as the number of caudal vertebrae up to the origin of the first dorsal fin (Ishiyama, 1952; Krefft, 1968*a*); the number of trunk vertebrae (Vtr) and total count ($V\Sigma$) are given according to Krefft (1968*a*).

Although Bigelow & Schroeder (1953) have employed X-ray photography in examinations of the snout, this method has not been used in the present study, because of the small extent of calcification of the rostral cartilages (Ishiyama & Hubbs, 1968). The rostral cartilages and rostral appendices were examined by dissection.

Systematic Discussion

Family **Rajidae**

Flat, depressed head and body, forming a rhomboidal disc. Eyes prominent, rising above level of head; spiracles close behind eyes. Tail moderately slender,

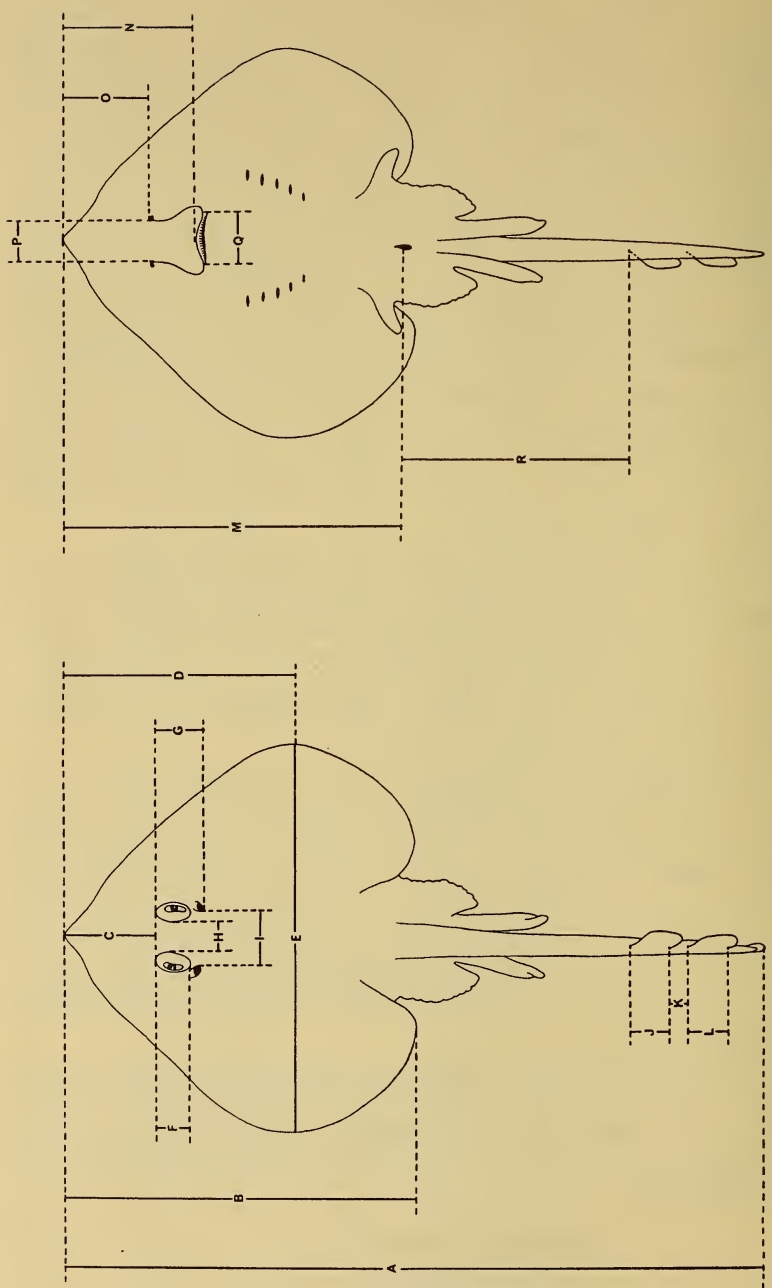


FIG. 1. Scheme of measurement for skate specimens.

A—total length; B—disc length; C—snout length; D—snout to greatest disc width; E—disc width; F—longitudinal diameter of eye; G—eye and spiracle; H—interorbital distance; I—interspiracular distance; J—base length of first dorsal fin; K—interdorsal space; L—base length of second dorsal fin; M—snout to middle of vent; N—preoral length; O—prenasal length; P—internasal distance; Q—mouth width; R—middle of vent to origin of first dorsal fin.

but not whip-like, with caudal fin reduced to a membranous fold. Two dorsal fins. Pelvic fins with outer margins either weakly concave, or so deeply concave that anterior lobe forms separate, three-jointed, limb-like structure. Skin on dorsal surface of disc and tail with small spinules and spines, or larger thorn-like denticles, or both, but without serrate tail spines. Ventral surface smooth, or with pointed spines, or with small, flattened asperities.

In this family eight genera are distinguished, but only three of these occur in the eastern South Atlantic.

Key to Genera

1 (*a*) Anterior lobe of pelvic fin forming slender, three-jointed limb-like structure, separate externally from posterior fin-like region (fig. 2 A) .. .. *Cruriraja*

(*b*) Anterior lobe of pelvic fin continuous externally with posterior region along outer margin of fin, not forming a separate limb (fig. 2 B) 2

2 (*a*) Anterior radials of pectoral fins falling distinctly short of tip of snout; rostral appendices fused to stout, rod-like rostral bar throughout their length. Shield usually present in clasper glans (figs 5–11, 15, 17–19) .. .. *Raja*

(*b*) Anterior radials of pectoral fins extending almost to tip of snout; rostral appendices broadly united basally and hanging posteriorly free from soft, delicate rostral bar, without anterior notch; each appendix separated posteriorly from axial bar by a notch about ½ as long as appendix. Shield absent in clasper glans (fig. 21 B) .. .. *Bathyraja*

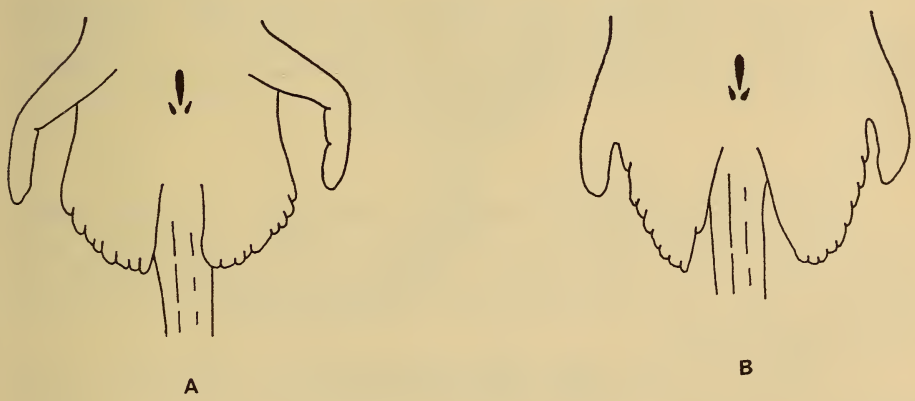


Fig. 2. Ventral surface of pelvic fin: A. *Cruriraja*; B. *Raja*.

Genus CRURIRAJA Bigelow & Schroeder

Cruriraja Bigelow & Schroeder, 1948: 549; 1953: 313. Smith, 1964: 286. Wallace, 1967: 7, fig. 3.

Type-species: *Cruriraja atlantis* Bigelow & Schroeder, 1948.

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics deeply notched, to form an anterior, limb-like structure, consisting of three articulated segments, externally distinct from posterior, fin-like lobe of pelvic. Tips of anterior rays of pectorals falling short of tip of rostral cartilage.

Three species of *Cruriraja* have been recorded in the southern African region (Smith, 1964); one east coast species, one west coast species and one species common to both coasts.

Key to species

1 (*a*) No thorns on tip of snout, along rostral ridge or in interspace between dorsal fins *C. durbanensis*

(*b*) A group of spines on tip of snout and along rostral ridge; thorns in dorsal interspace 2

2 (*a*) No thorns on mid-line of back above anterior half of abdominal region. Interdorsal space usually less than half base length of first dorsal. Single enlarged thorn on anterior dorsal border of clasper glans; ventral border with dermal denticles.. *C. triangularis*

(*b*) Thorns present on mid-line of back above anterior half of abdominal region. Interdorsal space usually greater than half base length of first dorsal. A single, enlarged thorn on anterior dorsal border of clasper glans and an eperon on anterior ventral border (fig. 4) *C. parcomaculata*

Cruriraja durbanensis (Von Bonde & Swart, 1923)

(Fig. 3)

Raia durbanensis Von Bonde & Swart, 1923: 11, pl. 22, fig. 1. Barnard, 1925: 69.
Cruriraja durbanensis: Bigelow & Schroeder, 1948: 550; 1953: 315; 1962: 199. Smith, 1964: 287. Wallace, 1967: 7.

Types

The holotype, a juvenile male (232 mm total length) taken in 859 metres at 30°10·00′S, 14°33·00′E, formerly in the collection of the Government Marine Survey; now missing. The paratype, a female (311 mm total length) also missing. The locality and depth for the paratype are noted as unknown.

Material

No specimens were available.

Unfortunately, the name *C. durbanensis* is misleading, as the type locality given for this species, Station 343 (Von Bonde & Swart, 1923), is at a point in the Atlantic Ocean about 640 km north-west of Cape Town. Bigelow & Schroeder (1948, 1953) erroneously give the locality as off the Natal coast in 420 fathoms (769 m).

C. durbanensis is most easily distinguished from all other species of this genus by the fact that there are no thorns on the snout and rostral cartilage, and no thorns in the interdorsal space.

Description (Barnard, 1925: 69)

'Width equal to distance from snout almost to middle of tail. In male snout pointed but not produced, about 90°, anterior margin almost straight. In female snout rounded, without point, anterior margins undulate. Outer pectoral angle broadly rounded, hind margin moderately convex. Eye a little less than interorbital width, 4 in preocular length of snout. Whole upper surface of disc and upper and lateral surfaces of tail covered with spinelets; in male 1 large spine in front of, 2 behind orbit; in female 5 and three respetively; 2 (male) or 1 (female) suprascapular spines; a median row from occiput

to 1st dorsal in male; in female only extending about half-way along tail; lower surface quite smooth.'

Colour

'Reddish brown, lighter beneath.'

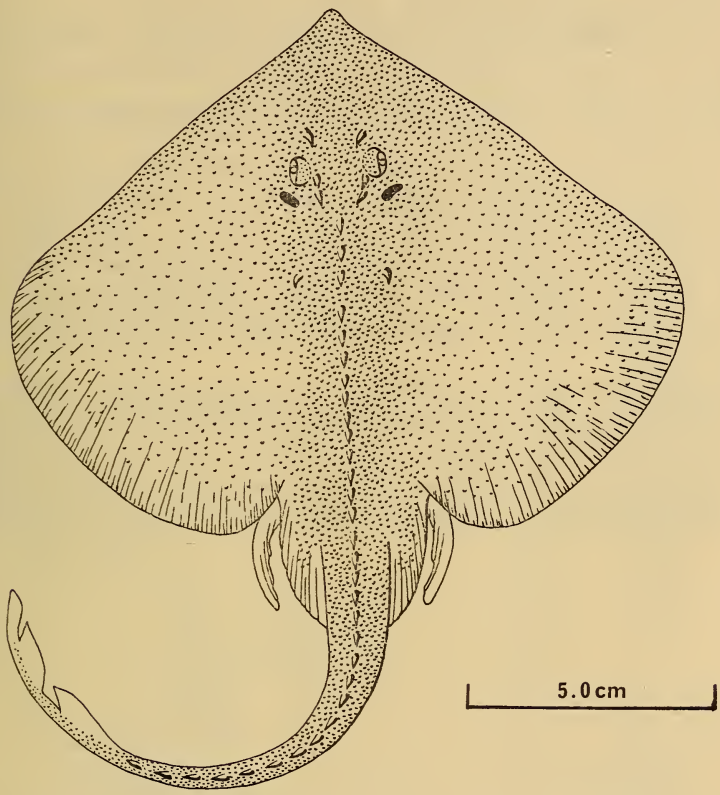


Fig. 3. *Cruriraja durbanensis:* the type, immature male. Dorsal view. (After Von Bonde & Swart, 1923.)

Cruriraja parcomaculata (Von Bonde & Swart, 1923)

(Pl. 1A; Figs 4 A, 4 B)

Raia parcomaculata Von Bonde & Swart, 1923: 9, pl. 21, fig. 2.
Raja parcomaculata: Norman, 1935: 46.
Raia miraletus (*non* Linnaeus) Barnard, 1925: 68 (*partim*).
Raia smithi (*non* Müller & Henle) Smith, 1961: 66, fig. 68.
Raja caudaspinosa (*non* Von Bonde & Swart) Norman, 1935: 43 (*partim*).
Cruriraja parcomaculata: Bigelow & Schroeder, 1948: 550; 1953: 315; 1962: 199. Smith, 1964: 288, pl. 26, fig. 27. Wallace, 1967: 11.

Types

The holotype, a juvenile (181 mm total length), trawled off Durban (29°57·30′S, 31°34·15′E) in 545 metres, formerly in the collection of the

Government Marine Survey; now missing. A single paratype, juvenile female (108 mm total length) taken at the same locality and formerly in the same collection, now in the collection of the British Museum (Natural History).

Material

11 specimens of both sexes (160–550 mm total length) trawled off the west coast from WNW Lüderitzbucht to Cape Columbine in 267–622 metres and from the east coast in Algoa Bay at 193 metres. 8 specimens preserved in the collection of the South African Museum (SAM 24352–4, 24412, 24662).

C. parcomaculata was thought to be an east coast species (Smith, 1964), but it is now known to occur along the south and west coasts of southern Africa, where it is taken fairly regularly in commercial trawls. While the type specimens were taken off Durban (Von Bonde & Swart, 1923), Wallace (1967) has not recorded the species during a three-year survey, so that *C. parcomaculata* probably does not extend further north than about Port Alfred on the east coast, and is replaced by *C. triangularis* in the region Durban to Barra da Falsa (Wallace, 1967).

C. parcomaculata closely resembles the east coast species *C. triangularis*, but differs from it in having a compatatively broader disc, a greater interdorsal space and a continuous median series of thorns along the back, which in adults, where there is development of lateral rows, gives rise to the distinctive 'cross' pattern of spines. It should be noted that the definitive character given

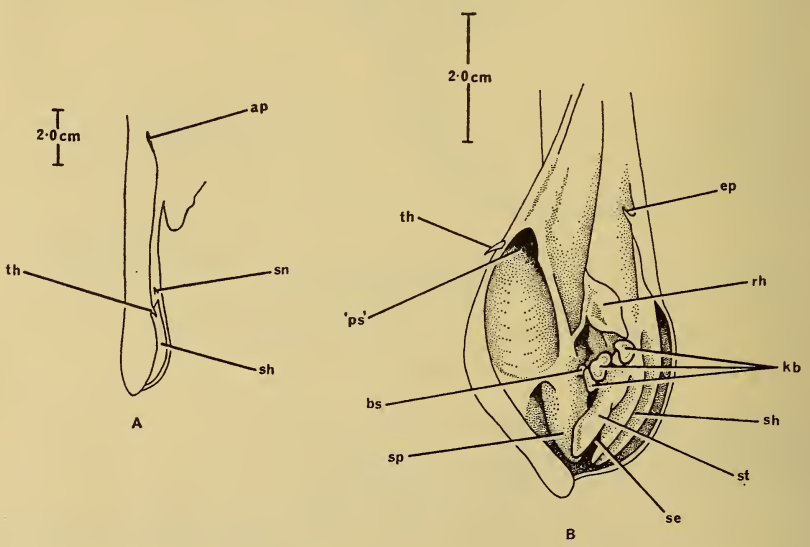


FIG. 4. *Cruriraja parcomaculata.*
A: external view of right clasper from the dorsal side.
B: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; bs—boss; hp—hypopyle; kn—knob; 'ps'—'pseudosiphon'; rh—rhipidion; sh—shield; ep—eperon; sp—spike; st—sentinel; th—thorn; se—sentina.

by Smith (1964) for the separation of the two species – the position of the line across the widest part of the disc – is not so marked in adults, where there is an overlap of critical values. Comparison of the claspers of the two species has shown that there are major differences in both external and internal structures. This confirms that *C. parcomaculata* and *C. triangularis* are distinct species.

A large specimen (BM. 1935. 5.2.64) taken by the *Discovery* and identified as *R. caudaspinosa* by Norman (1935) is in fact *C. parcomaculata*.

TABLE 2. *C. parcomaculata*. Measurements expressed as permillage of the total length. Number of specimens 11.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	591	568–627
Disc length	451	427–521
Snout to greatest disc width	273	249–314
Snout to middle of vent	390	360–437
Middle of vent to 1st dorsal origin	479	459–519
Snout length	95	84–108
Preoral length	110	99–118
Prenasal length	83	76–88
Eye, longitudinal diameter	41	29–55
Eye and spiracle	52	44–60
Spiracle	23	16–31
Interorbital distance	32	28–38
Interspiracular distance	71	66–82
Internasal distance	50	44–59
Mouth width	61	52–70
Gill slit lengths: 1st	16	14–21
3rd	17	15–20
5th	14	10–17
Distance between inner ends of gill slits:		
1st	126	116–140
5th	53	46–60
Pelvic fin (anterior lobe):		
anterior margin	114	101–133
length	97	79–116
base width	27	21–34
1st dorsal fin: height	28	20–34
base length	42	32–59
2nd dorsal fin: height	27	20–35
base length	38	32–48
Interdorsal space	39	28–49

Description

Disc 1·2–1·4 times as broad as long, its width 1·6–1·8 in total length; angular in front, with maximum angle in front of spiracles 120° in juveniles and females and 112° in adult males; anterior margins weakly concave close behind tip of snout and again at level of spiracles; outer angles narrowly rounded, posterior angles broadly so; posterior and inner margins convex. Axis of greatest breadth 1·4–1·6 times as far from tip of snout as from posterior edge of disc. Tail with lateral folds, well developed and expanded on posterior third, so that tail is narrower at middle of length than distally; its length from

middle of vent to origin of first dorsal fin 1·1–1·2 times the distance from middle of vent to tip of snout; its length from middle of vent to tip of tail 1·4–1·7 times the distance from middle of vent to tip of snout.

Juvenile specimens with 5 thorns around inner edge of each orbit and 1 pair of widely separated thorns between spiracles; 1 median nuchal thorn and 2 scapular thorns on each side; a row of 23–27 thorns along mid-line of back and tail, extending from immediately behind scapular region to origin of first dorsal; median row flanked on each side by an irregular series of smaller spines; 2–3 thorns in dorsal interspace. Whole upper surface of disc with fine spinules, except on outer posterior edges; larger spines on tip of snout and along anterior margins. Lower surface of disc and tail completely smooth.

Adult specimens with 11–13 thorns around inner margin of each orbit and spiracle; 2 pairs of thorns between spiracles; 2 (sometimes 4) median nuchal thorns, usually arranged in a double series; 3 scapular thorns on each side; 4–5 irregular rows of stellate-based thorns along mid-dorsal region from nuchal thorns to origin of first dorsal, diminishing to a double series of slender, recurved thorns about half-way along tail; a single lateral row of smaller spines on each side of tail, from about posterior edge of pelvics to about level of dorsal interspace; 4–8 thorns in interspace between dorsals. A group of thorns on tip of snout and along rostral cartilage, and numerous, irregularly arranged, stellate-based spines along anterior margins of disc to outer angles. Otherwise smooth on upper surface, except in some cases a few small spines at inner margin of pectoral. Lower surface of disc and tail without spines.

Snout slightly pointed but not produced, its length in front of orbits 2·6–3·5 times as long as distance between orbits; its length in front of mouth 1·9–2·4 times as long as spiracles; distance between orbits 1·0–1·8 in length of orbit. Rostral cartilage projecting from cranium as hard bar; anterior rays of pectorals extending about half the distance from front of orbits to tip of snout.

Mouth almost straight; nasal curtain not fringed; expanded posterior margin of nostril conspicuously fringed. Teeth arranged in 39–44 rows in upper jaw, juveniles with 30–31 rows; teeth blunt and flat and arranged in quincunx in juveniles, but sharp pointed and regularly arranged in adults.

Pelvic fins divided into slender, limb-like anterior lobe, arising separately from ventral surface of disc, and posterior fin-like lobe.

Dorsal fins similar in shape with rounded apices; first dorsal usually larger than second; dorsal interspace varying considerably from 0·6–1·5 times as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 66–69.

Colour

Juveniles uniformly brown, sometimes with scattered darker patches on disc and tail. Adults typically uniformly brown, with irregular lighter and darker areas. Lower surface of disc and tail white.

Genus RAJA Linnaeus, 1758

Raja Linnaeus, 1758: 231.

Type-species: *Raja clavata* Linnaeus, 1758 (as designated by Jordan & Gilbert, 1883).

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics more or less concave, but not deeply notched and not forming separate, limb-like structure. Tips of anterior rays of pectoral fins falling short of rostral appendices. Rostral cartilage stout and bar-like, without segment; rostral appendices fused to lateral edges of rostral cartilage throughout length. Characters otherwise the same as for the family.

Genus BATHYRAJA Ishiyama, 1968

Bathyraja Ishiyama & Hubbs, 1968: 407, figs 1, 2.

Type-species: *Bathyraja isotrachys* (Günther, 1877)

Pectorals with radials of ordinary form, without lateral processes. Outer margins of pelvics more or less concave, but not forming a separate, anterior, limb-like structure. Rostral appendices broadly united basally with rostral bar, and extending posteriorly as unnotched processes; posterior wings of rostral appendices separate from rostral bar. Shield absent in clasper glans. Characters otherwise the same as for the family.

Note: Ishiyama & Hubbs (1968) also define the genus *Bathyraja* by the presence of a pseudosiphon in the clasper glans. Investigation of the claspers of the *radiata*-complex has revealed that a true pseudosiphon, as defined by Ishiyama (1958) and subsequently modified by Ishiyama & Hubbs (1968), is definitely present in the species *R. radiata*, *R. doellojuradoi*, *R. hyperborea* and *R. robertsi* n.sp. Furthermore, Ishiyama & Hubbs (1968) restrict *Bathyraja* to the Indo-Pacific and *Breviraja* to the Atlantic, but the distributional pattern of *Bathyraja smithii* shows this to be incorrect. Krefft (personal communication) suggests that *Breviraja* is confined to slope areas in the tropics, whereas *Bathyraja* is a bipolar, antitropical genus.

KEY TO SPECIES OF Raja AND Bathyraja

1 (*a*) Mucus pores on ventral surface of disc pigmented, appearing as small black spots and streaks 2
(*b*) Mucus pores on ventral surface of disc not pigmented 6
2 (*a*) Tail long and slender; snout markedly produced and very pointed *R. lanceorostrata*
(*b*) Tail not long and slender; snout somewhat pointed but not very produced .. 3
3 (*a*) Ventral surface of disc completely covered by small, close-set asperities *R. springeri*
(*b*) Ventral surface of disc never completely covered by small asperities, although spines and spinules may be present on tip of snout, internasal region and anterior margins of disc 4
4 (*a*) Distance from middle of vent to tip of snout greater than distance from middle of vent to tip of tail, by an amount about equal to or greater than the preoral length *R. doutrei*
(*b*) Distance from middle of vent to tip of snout equal to or greater than the distance from middle of vent to tip of tail, by an amount less than half the preoral length .. 5
5 (*a*) Snout produced; interorbital distance about 5·5 in snout length; internasal distance about 3 in preoral length .. .. *R. stenorhynchus*

KEY TO SPECIES OF Raja AND Bathyraja (*continued*)

(*b*) Snout not produced; interorbital distance 3–4 in snout length; internasal distance about 2 in preoral length .. .. *R. pullopunctata*

6 (*a*) Distance from middle of vent to origin of first dorsal fin greater than distance from middle of vent to tip of snout 7

(*b*) Distance from middle of vent to origin of first dorsal fin less than distance from middle of vent to tip of snout 8

7 (*a*) Upper surface of disc and tail completely covered with fine spinules; a single row of spines along mid-dorsal region of back and tail .. .. .. *R. spinacidermis*

(*b*) Upper surface of disc and tail without close-set spinules; 3 rows of thorns along mid-dorsal region of back and 5 rows on tail .. .. *R. caudaspinosa*

8 (*a*) Upper surface of disc and tail completely covered with fine, close-set spinules; no enlarged thorns on disc or tail .. .. *R. spinacidermis*

(*b*) Upper surface of disc and tail never completely covered with spinules (except some juveniles); larger thorns always present on disc or tail 9

9 (*a*) Less than 30 rows of teeth in upper jaw .. .. *B. smithii*

(*b*) More than 30 rows of teeth in upper jaw 10

10 (*a*) Snout produced and sharply pointed .. .. *R. alba*

(*b*) Snout not produced and not sharply pointed.. 11

11 (*a*) Ocelli present on upper surface of disc 12

(*b*) Ocelli absent on upper surface of disc.. 14

12 (*a*) Ocelli black and yellow marbled 21

(*b*) Ocelli not marbled 13

13 (*a*) Ocelli circular or only very slightly ovate, usually consisting of three definite rings of colour .. .. *R. miraletus*

(*b*) Ocelli strongly horizontally ovate, consisting of a single dark ring enclosing one or two dark spots .. .. *R. clavata*

14 (*a*) Distance from middle of vent to tip of snout about 1·5 times greater than distance from middle of vent to tip of tail 15

(*b*) Distance from middle of vent to tip of snout less than distance from middle of vent to tip of tail 16

15 (*a*) Upper surface of disc with stellate-based thorns on anterior margins, rostral cartilage and posterior angles. Ventral surface of disc white with some scattered darker blotches *R. radiata*

(*b*) Upper surface of disc without stellate based thorns on anterior margins, rostral cartilage and posterior angles. Ventral surface of disc dark grey with white triangular patches between nostrils, around mouth and at pectoral girdle .. .. .. *R. robertsi*

16 (*a*) Less than 50 rows of teeth in upper jaw 17

(*b*) More than 50 rows of teeth in upper jaw 21

17 (*a*) Median row of thorns along back and tail absent. No thorns on rostral cartilage *R. ravidula*

(*b*) Median row of thorns on back and tail always present. Thorns present on rostral cartilage 18

18 (*a*) A single row of thorns along mid-dorsal region of back and tail; auxiliary rows of thorns (when present) always lateral. Number of precaudal vertebrae 46–54 .. 19

(*b*) 3 or more rows of thorns along mid-dorsal region of back and tail; auxiliary rows of thorns semi-lateral in position; number of precaudal vertebrae 55–69 20

19 (*a*) Shield in clasper glans well developed and exposed (fig. 11 C); dorsal surface of disc grey with numerous darker regular spots. .. .. *R. straeleni*

(*b*) Shield in clasper glans poorly developed (fig. 10 C); dorsal surface of disc with or without numerous irregular darker blotches. .. .. *R. clavata*

20 (*a*) Reduction in size to eventual loss of mid-dorsal rows of thorns from disc to tail; lower surface of tail uniformly grey with white distal tip; precaudal vertebral count 65–69; clasper with a slit and a cleft (fig. 15 C) .. .. *R. dissimilis*

(*b*) Mid-dorsal rows of thorns large and continuous to origin of first dorsal fin; lower surface of tail white or with scattered darker blotches; precaudal vertebral count 55–63; clasper with two slits (fig. 17 C) .. .. *R. confundens*

KEY TO SPECIES OF Raja AND Bathyraja (continued)

21 (*a*) Distance from middle of vent to origin of first dorsal fin longer than distance from tip of snout to greatest disc width, by an amount greater than the preoral length; precaudal vertebral count 70; spike in clasper glans bilobed (fig. 19 C) .. .. .. *R. wallacei*

(*b*) Distance from middle of vent to origin of first dorsal fin longer than distance from tip of snout to greatest disc width, by an amount less than the preoral length; precaudal vertebral count 55–58; spike in clasper glans bulbous but not bilobed (fig. 18 C) *R. leopardus*

Note: *R. ackleyi* Garman has been recorded from the south Atlantic (Poll, 1951) at 3°10′S, 9°36′E and 4°58′S, 11°20′30″E, but this is outside the area of this survey.

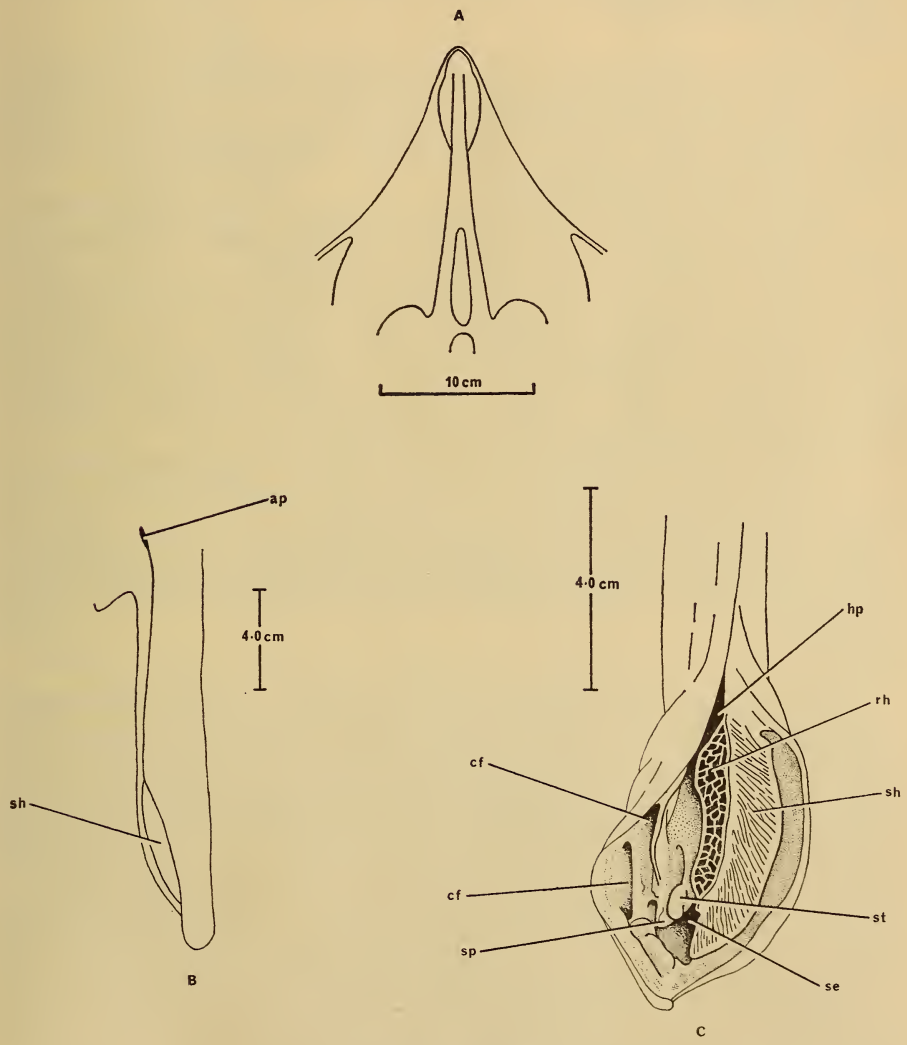


FIG. 5. *Raja doutrei.*

A: rostral bar and rostral appendices.
B: external view of left clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; hp—hypopyle; rh—rhipidion; sh—shield; sp—spike; st—sentinel.

Raja doutrei Cadenat, 1960

(Pl. 1B; Figs 5 A, B, C)

Raia doutrei Cadenat, 1960: 294, figs 1–11, 13, 15.
Raja batis (*non* Linnaeus) Hulley, 1966: 512.

Type

The holotype, a juvenile male (591 mm total length) taken at Sud Fosse Kayar, Senegal, in 450–500 metres in the collection of the Muséum National d'Histoire Naturelle, Paris.

Material

Two adult males (845, 931 mm total length) taken SW by W Lüderitzbucht in 494 metres. Both specimens in the collection of the South African Museum (SAM 24699, 24700). A single female (SAM 34564) from the same locality not suitable for measurement.

This is a new record for this species in the South Atlantic. The specimens were originally thought to be *R. batis* Linnaeus (Hulley, 1966), but comparison of the claspers with those of *R. batis* from the North Atlantic (Hulley, 1966: figs 6, 7) has revealed that these specimens do not belong to the latter species. However, the specimens are identical in shape, coloration, teeth count and spination pattern, particularly on the tail, to *R. doutrei* from the coast of Senegal (Cadenat, 1960). Counts of the number of precaudal vertebrae (Vprd 46 in the type) confirm this identification.

R. doutrei closely resembles the east coast species *R. stenorhynchus*, but may be distinguished from this species by its comparatively shorter, narrower snout, longer and wider disc, and by its longer tail. Furthermore, it appears that the tooth count in the upper jaw is slightly lower than that of *R. stenorhynchus*, although the validity of this small difference as a taxonomic character is open to question.

Description

Disc about 1·2 times as broad as long, its width 1·3–1·4 in total length; maximum angle in front of spiracles 72°; anterior margins sinuous from snout to outer angles, convex at level of nostrils and concave a little behind level of mouth; outer angles sharply rounded, posterior margins gently convex. Axis of greatest breadth 1·5–1·9 times as far from tip of snout as from posterior edge of disc. Tail expanded distally with well-developed lateral folds, especially on posterior third; its length from middle of vent to origin of first dorsal fin 2·0–2·2 in length from middle of vent to tip of snout; its complete length from middle of vent to tip of tail 1·5 in length from middle of vent to tip of snout.

Adults with 6–7 thorns around inner margins of each orbit and above each spiracle; 0–1 very small, median nuchal thorn. A series of 13–26 thorns along midline of tail from above vent to origin of first dorsal; 1–2 thorns in dorsal interspace. No lateral rows of thorns on tail in adult males, but females typically with thorns in a single series on each side. Spines on dorsal surface

TABLE 3. *R. doutrei*. Measurements expressed as permillage of the total length. Number of specimens 2.

Character	SAM 24699	SAM 24700
Total length	1 000	1 000
Disc width	723	751
Disc length	605	626
Snout to greatest disc width	398	374
Snout to middle of vent	595	600
Middle of vent to 1st dorsal origin	300	269
Snout length	197	199
Preoral length	192	192
Prenasal length	175	173
Eye: longitudinal diameter	38	46
Eye and spiracle	53	56
Spiracle	17	23
Interorbital distance	51	50
Interspiracular distance	71	68
Internasal distance	91	95
Mouth width	91	99
Gill slit lengths 1st	17	19
3rd	17	20
5th	13	17
Distance between inner ends of gill slits:		
1st	153	164
5th	94	95
1st dorsal fin: height	33	44
base length	49	45
2nd dorsal fin: height	49	45
base length	48	45
Interdorsal space	18	17

on tip of snout and along anterior margins of disc from about opposite eyes to outer angles. Ventral surface with spines on snout and along anterior margins to level of mouth. Otherwise smooth on both dorsal and ventral surfaces.

Snout produced and slightly pointed, its length in front of orbits 3·8–4·0 times as long as distance between orbits; its length in front of mouth 2·0–2·1 times as great as distance between nostrils. Orbits 2·0–2·2 times as long as spiracles; distance between orbits 1·1–1·3 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior tips of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 32 regular rows in upper jaw, each with a single, large, posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in size and shape, with broadly rounded apices. Small but definite interspace between dorsals, its length 37% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 47–49 (male), 43 (female).

Colour

Upper surface of disc and tail uniformly brown, with some scattered, irregular, darker blotches. Lower surface brown; terminal ends of mucus pores pigmented, appearing as widely-spaced black spots on the snout and anterior margins of the disc.

Raja pullopunctata Smith, 1964

(Pl. 2 A, B. Figs 6 A, B, C)

Raia pullopunctata Smith, 1964: 285, pl. 25.
Raja pullopunctata: Hulley, 1966: 505, figs 4, 5. Wallace, 1967: 13, fig. 7.
Raia batis (*non* Linnaeus) Thompson, 1914: 156. Von Bonde & Swart, 1923: 3. Barnard, 1925: 70, *non* pl. 4, fig. 3. Smith, 1961: 66, pl. 3, fig. 65.
Raja batis (*non* Linnaeus) Norman, 1935: 39. Fowler, 1941: 385. Bigelow & Schroeder, 1953: 146.
Raja campbelli Wallace, 1967: 24, fig. 12.
Raia stabuliforis: Von Bonde & Swart, 1923: 12.

Types

The holotype of *R. pullopunctata*, a juvenile male (205 mm total length) and paratype, a female (175 mm total length), both trawled in 183 metres in Algoa Bay, in the collection of the J. L. B. Smith Institute of Ichthyology, Grahamstown.

The holotype of *R. campbelli*, a female (663 mm total length) and paratype, a male (386 mm total length), trawled east of Durban in 320 metres and north-east of Durban in 137 metres respectively, in the collection of the Oceanographic Research Institute, Durban.

Material

Seven female and four male specimens (221–1250 mm total length) trawled from west of Cape Town to Port Alfred in 91–457 metres, including the types and paratypes of *R. pullopunctata* and *R. campbelli*. Eight specimens preserved in the collection of the South African Museum (SAM 22635, 22652, 24349–51, 24456, 24497).

On the basis of external morphology, Smith (1964) distinguished between *R. pullopunctata* and the European species *R. batis*, to which the South African material had previously been referred. This distinction has been confirmed by Hulley (1966) after detailed examination of the clasper structures of the two species.

Recently Wallace (1967) has described a new species of 'black-bellied' skate, *R. campbelli*, from the Natal coast. This species closely resembles *R. pullopunctata* but was distinguished from it on the basis of the shape of the snout and the spination of the rostral cartilage. It must be pointed out, however, that Wallace only examined juvenile specimens of *R. pullopunctata* (340 mm maximum total length). Specimens of *R. pullopunctata* in the collection of the South African Museum, show a range of variation in the above characters.

In more mature specimens (387–1250 mm total length) spinules appear first on the ventral tip and then on the dorsal tip of the rostral cartilage, while the shape of the snout varies with age: width of disc at level of orbits 2·3–2·6 times the preorbital length of the snout in juveniles (221–344 mm total length); 2·0–2·3 times in more mature specimens (387–540 mm total length); and

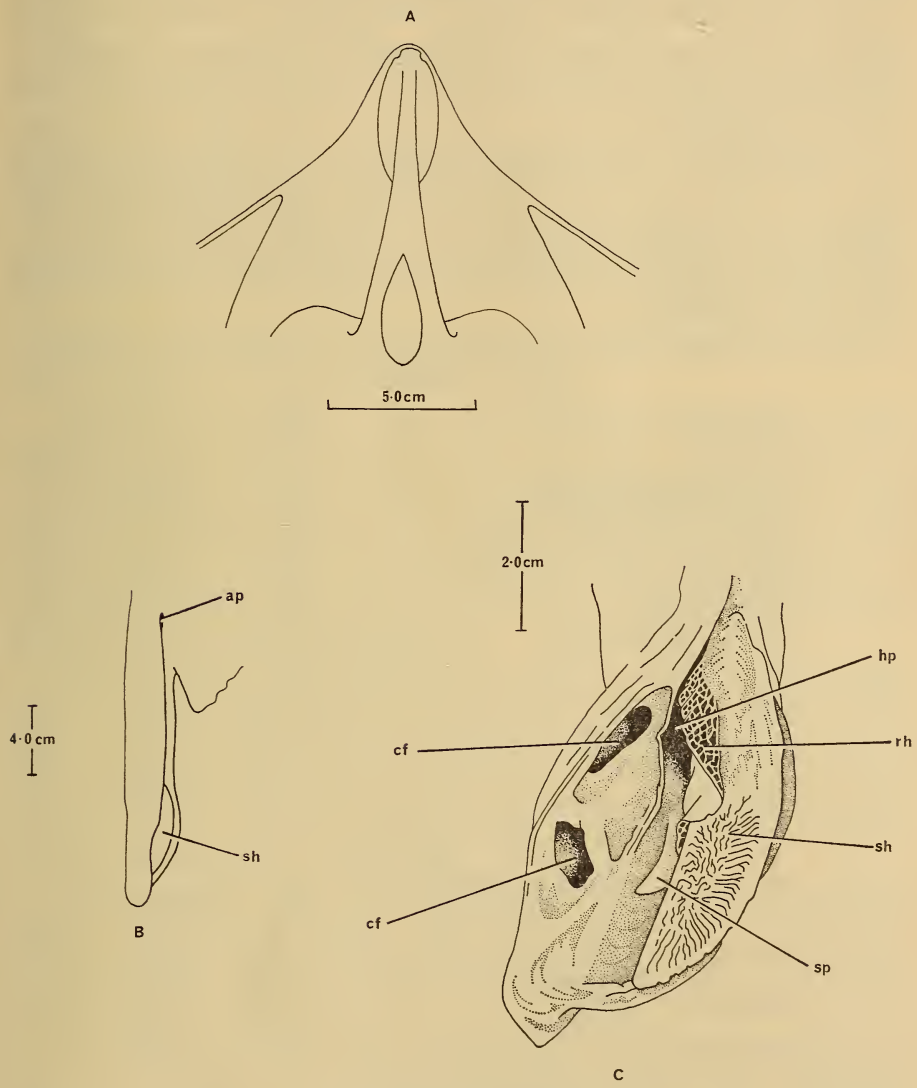


Fig. 6. *Raja pullopunctata*.

A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; hp—hypopyle; rh—rhipidion; sh—shield; sp—spike.

1·8–1·9 times in adult specimens (660–1250 mm total length). It is therefore held that specimens described as *R. campbelli* are specimens of *R. pullopunctata*. This is further supported by the fact that there is no difference in the precaudal vertebral count between the two species.

R. pullopunctata most closely resembles *R. flavirostris* Philippi from the Falkland Islands, but may be distinguished from this species by the length of the tail and by the number of teeth in the upper jaw. Examination of the claspers of *R. flavirostris* has shown the two species to be distinct. Furthermore, the precaudal vertebral count in *R. flavirostris* appears to be slightly less than that for *R. pullopunctata*.

R. pullopunctata is most easily distinguished from other South African skates, except *R. lanceorostrata* and *R. stenorhynchus*, by the black-spotted ventral surface of the disc and by the presence of a single large, median nuchal thorn (sometimes 2). It may be separated from *R. lanceorostrata* by the shape of the tail and snout, and from *R. stenorhynchus* by the shape of the disc and the nature of the rostral cartilage.

TABLE 4. *R. pullopunctata*. Measurements expressed as permillage of the total length. Number of specimens 10.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	734	678–784
Disc length	573	550–598
Snout to greatest disc width	320	294–366
Snout to middle of vent	526	493–567
Middle of vent to 1st dorsal origin	304	272–323
Snout length	165	147–189
Preoral length	167	156–183
Prenasal length	136	120–152
Eye: longitudinal diameter	40	29–46
Eye and spiracle	54	50–58
Spiracle	22	19–26
Interorbital distance	48	43–46
Interspiracular distance	72	70–75
Internasal distance	88	79–95
Mouth width	92	88–96
Gill slit lengths: 1st	15	12–20
2nd	16	12–23
5th	13	11–19
Distance between inner ends of gill slits: 1st	162	155–171
5th	93	82–98
1st dorsal fin: height	34	24–39
base length	52	42–62
2nd dorsal fin: height	30	18–35
base length	49	40–58
Interdorsal space	28	21–36

Description

Disc about 1·2–1·4 times as broad as long, obtuse in front, with anterior angle in front of spiracles 92°–108°; anterior margins weakly concave posterior to snout in juveniles (width of disc at level of orbits 2·3–2·6 times in preorbital

length of snout), but more sinuous and particularly concave abreast of spiracles in older specimens (width of disc at level of orbits 1·8–2·3 times in preorbital length of snout); posterior and outer angles broadly rounded. Axis of greatest breadth 1·1–1·4 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds (wide in adults), its length from middle of vent to origin of first dorsal fin 1·6–1·9 in length of middle vent to tip of snout.

Juvenile specimens with 2 thorns in front of orbit and 1 behind; a single, large, median nuchal thorn; a row of 8–12 thorns along mid-line of tail, from above vent to origin of first dorsal fin; and 1 thorn in interspace between first and second dorsals. No lateral rows of spines on tail. Otherwise entire dorsal and ventral surfaces of disc and tail naked.

Larger specimens with 3–4 thorns around inner margin of orbit; a single, median nuchal thorn (sometimes worn); a row of 10–12 thorns along mid-line of tail, from above vent to origin of first dorsal; and 1–2 thorns in dorsal interspace. No lateral rows of thorns on tail. Upper surface of disc smooth, but lower surface with spinules on tip of snout and anterior edges of disc to about level of nostrils, and on internasal area.

Adult specimens with 5–8 thorns around inner margin of orbit; 1 median nuchal thorn (sometimes 2), usually worn; a row of 26–27 thorns along mid-line of tail, from above vent to origin of first dorsal; and 3–4 thorns in dorsal interspace. A single, irregular row of lateral caudal thorns (15–20) on each side of tail, from about posterior edge of pelvics to interspace between dorsals. Dorsal surface of disc and tail with widely spaced, blunt asperities, except on suprascapular region. Spinules on ventral surface of snout, anterior margins to level of nostrils and on internasal area.

Snout produced, more markedly so in adults, its length in front of orbits 3·4–4·1 times as long as distance between orbits; its length in front of mouth 1·9–2·0 times as great as distance between nostrils. Orbits 1·5–1·9 times as long as spiracles; distance between orbits 1·5–1·9 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to the bar throughout their length; tips of anterior rays of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth with single, large cusp in males, but more or less flat in females and juveniles, arranged in 53–58 rows in upper jaw.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First dorsal fin usually only slightly larger than second, but similar in shape, with convex anterior margin and broadly rounded apex; interspace between dorsals 47–73% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 50–58.

Colour

Dorsal surface light brown to biscuit, sometimes darker, with numerous

small darker spots and blotches. Ventral surface greyish, with terminal ends of mucus pores darkly pigmented, appearing as black spots and streaks.

Raja caudaspinosa (Von Bonde & Swart, 1923)

(Pl. 3 A, B; Figs 7 A, B, C)

Raia caudaspinosa Von Bonde & Swart, 1923: 8, pl. 21, fig. 1. Barnard, 1925: 66.
Raja caudaspinosa: Norman, 1935: 43 (*partim*). Fowler, 1941: 376.
non Raia caudaspinosa: Smith, 1961: 67, *non* fig. 72 (= *R. leopardus*).
Raia albalinea Von Bonde & Swart, 1923: 6, pl. 20, fig. 1.

Types

The holotype of *R. caudaspinosa*, a female (346 mm total length), trawled off the Natal coast in 512 metres, formerly in the collection of the Government Marine Survey; now missing.

The paratype of *R. albalinea*, a juvenile female (108 mm total length), taken at 32°3·00'S, 16°2·00'E in 512 metres, formerly in the collection of the Government Marine Survey; now in the British Museum (Natural History). The type of *R. albalinea* taken by the Government Marine Survey, now missing.

Material

31 specimens of both sexes (304–580 mm total length) trawled between 292 and 914 metres from Port Nolloth to west of Cape Town. 29 specimens preserved in the collection of the South African Museum (SAM 23187, 24420, 24449).

Although the number of precaudal vertebrae in the tail is indicative of the genus *Bathyraja* (Ishiyama & Hubbs, 1968), this species has been retained in the genus *Raja* because of the structure of the rostral bar and rostral appendices, and because both a rhipidion and shield are present in the clasper glans.

While resembling *R. wallacei* and *R. confundens* in the heavy spination of the tail, *R. caudaspinosa* may be separated from these and from all other known South African species except juvenile specimens of *R. spinacidermis* by virtue of the fact that the distance from the middle of the vent to the origin of the first dorsal fin is greater than the distance from the middle of the vent to the tip of the snout. In this and other characters, *R. caudaspinosa* most closely resembles *R. fyllae* Lütken from the northern Atlantic, but differs in being comparatively narrower across the disc, having a shorter snout and a narrower tail than the latter species. Unlike *R. fyllae*, juvenile specimens of *R. caudaspinosa* possess dark cross-barring on the tail, which is more typical of *R. senta* Garman, but they differ from this species in spination. Furthermore, Bigelow & Schroeder (1953: 199) report that 'the range of *R. fyllae* appears to be defined by its preference for a narrow temperature range of a few degrees above the freezing point of salt water', so that while this condition may be satisfied on the South African west coast, it seems unlikely that it applies to the waters off Natal (type taken in 512 metres).

Examination of the type of *R. albalinea* led both Barnard (1925) and Norman (1935) to include this species as a synonym of *R. caudaspinosa*. Unfortunately the type is now missing, but a comparison of the position of the vent in the paratype with its position in *R. caudaspinosa* has led the present author to accept this synonymy.

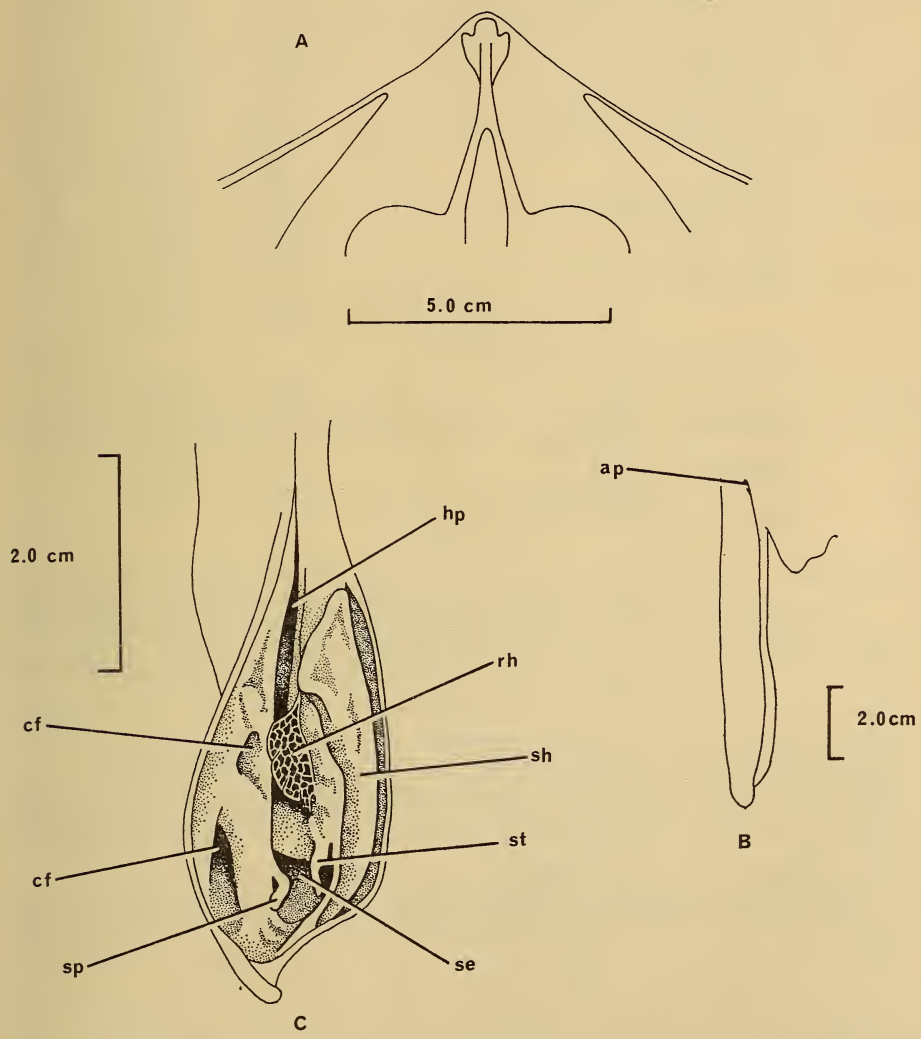


Fig. 7. *Raja caudaspinosa*.

A: rostral bar and rostral appendices.
B. external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; hp—hypopyle; rh—rhipidion; se—sentina; sh—shield; sp—spike; st—sentinel.

TABLE 5. *R. caudaspinosa*. Measurements expressed as permillage of the total length. Number of specimens 31.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	547	520–573
Disc length	405	379–446
Snout to greatest disc width	250	214–273
Snout to middle of vent	393	372–409
Middle of vent to 1st dorsal origin	468	450–494
Snout length	78	66–87
Preoral length	85	72–96
Prenasal length	63	55–74
Eye: longitudinal diameter	40	36–43
Eye and spiracle	49	46–52
Spiracle	19	16–23
Interorbital distance	33	30–36
Interspiracular distance	66	59–74
Internasal distance	60	55–64
Mouth width	68	57–78
Gill slit lengths: 1st	15	11–18
3rd	17	13–18
5th	13	10–16
Distance between inner ends of gill slits:		
1st	137	126–144
5th	71	58–83
1st dorsal fin: height	26	20–36
base length	51	44–57
2nd dorsal fin: height	26	21–34
base length	51	43–59
Interdorsal space	0	

Description

Disc about 1·2–1·4 times as broad as long, its width 1·7–1·9 in total length; conspicuously obtuse in front, with maximum angle in front of spiracles 125°–130°; anterior margins evenly convex in juveniles, but considerably concave at level of spiracles in adults, and particularly indented in adult males; outer angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1·1–1·9 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds along posterior third, its length from middle of vent to origin of first dorsal fin 1·1–1·3 times as great as distance from middle of vent to tip of snout.

Specimens typically with dorsal surface of disc smooth; large stellate-based thorns on anterior margins arranged in 4–6 irregular rows and on snout and rostral cartilage; 5–9 large thorns around inner margins of each orbit; 0–1 pair thorns between orbits and 1–2 pairs between spiracles; 4–5 median nuchal thorns with 3–5 thorns in a group posteriorly and 3–4 scapular thorns; a median series of 22–33 thorns along mid-line of back and tail to first dorsal origin, decreasing in size posteriorly, but never absent. Median series flanked by 1 row of equally large thorns on back, and 2 rows on each side on tail, making 5 rows of thorns in this region; lateral rows extending to origin of second dorsal. No interdorsal thorns. Small spines and spinules on anterior

edges of disc and on tail. Dorsal fins spinulose. Ventral surface smooth.

Snout obtuse and not produced, its length in front of orbits 2·0–2·6 times as long as distance between orbits; its length in front of mouth 1·2–1·6 times as great as distance between nostrils. Orbits 1·4–2·7 times as long as spiracles; distance between orbits 1·1–1·4 in length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending about two-thirds the distance forward from level of front of orbits towards tip of snout.

Mouth arched medially; nasal curtain deeply fringed; expanded posterior margin of nostril heavily fringed. Teeth in 32–36 rows in upper jaw, arranged in quincunx and closely crowded medially; flattened and blunt in females but with sharp posterior cusp in males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals confluent; second dorsal a little longer and lower than first, and continuous with caudal.

Number of precaudal vertebrae (Vprd) 66–73.

Colour

Upper surface of disc dusky-grey to brown, with or without some darker spots. Lower surface of disc and tail pale.

Raja spinacidermis Barnard, 1923

(Pl. 4 A, B)

Raia spinacidermis Barnard, 1923: 440; 1925: 73, pl. 4, fig. 6. Smith, 1961: 66.
Raja spinacidermis: Norman, 1935: 46. Fowler, 1941: 392.
Raja mollis Bigelow & Schroeder, 1950: 388, pl. 2; 1953: 237, fig. 51. Templeman, 1965: 268, figs 10–13. Krefft & Lübben, 1966: 389, figs 1, 2.
? *Raia plutonia:* Barnard, 1925: 68.

Type

The holotype of *R. spinacidermis*, a female (600 mm total length), probably trawled off Cape Point in deep water (locality label lost), formerly in the collection of the South African Museum; now in the collection of the British Museum (Natural History).

The holotype of *R. mollis*, a juvenile male (262 mm total length), from 41°53′N, 65°35′W in 1568 metres, in the collection of the United States National Museum.

Material

The holotype and two specimens, a juvenile male (377 mm total length) and a juvenile female (638·5 mm total length), taken by R.V. *Walther Herwig* at Station WH 195/67 (33°49′S, 17°13′E) in 1 000 metres, and at Station WH 196/67 (33°51′S, 17°41′E) in about 1 350 metres. These two specimens in the collection of the Institut für Seefischerei, Hamburg.

This species is retained in the genus *Raja* because the rostral bar extends

forwards beyond the anterior extremities of the pectoral rays, and because the precaudal vertebral count is within the range for this genus (Ishiyama, 1967).

R. spinacidermis was previously known only from a single adolescent specimen, the holotype, but two specimens were taken by R.V. *Walther Herwig* in deep water off Cape Town in 1967. It may be distinguished from all other known South African species by the spinulose nature of the whole upper surface of the disc and tail and by the complete absence of larger thorns.

R. mollis, which has been taken in deep water in the eastern and western North Atlantic (Bigelow & Schroeder, 1950, 1953; Templeman, 1965; Krefft & Lübben, 1966), so closely resembles *R. spinacidermis* in proportional dimensions, tooth count and in its peculiar spination pattern, that it is considered that these two species are synonymous. However, the vertebral count in *R. mollis* (Vtr 25–29; Vprd 67–72) is slightly higher than that of *R. spinacidermis* (Vtr 25; Vprd 60–65), the difference probably being due to environmental factors. Although the two are widely separated geographically, this fact seems to have little systematic bearing so far as deep-water species are concerned, cf. *R. richardsoni* (Garrick, 1961; Forster, 1965).

Although *R. spinacidermis* resembles *R. ravidula*, also from deep water off the Cape, in the spinulose nature of the upper surface of the disc, it differs markedly in the absence of thorns around the orbits, absence of thorns along the mid-dorsal region of the back and tail, and in tooth count. The snout is not as produced as in *R. ravidula*.

Norman (1935) held that the two spinulose juveniles, reported as *R. plutonia* Garman by Barnard (1925), are specimens of *R. spinacidermis*, for despite the presence of enlarged thorns above the orbits and along the mid-line of the back and tail, the median series of thorns in the larger specimen showed signs of disappearance, i.e. a similar relationship between juveniles and adults as in *R. fullonica* (Clark, 1926). Although these specimens were not available to the present author, two almost identical specimens (SAM 22911, 24450), answering exactly to Barnard's (1925) description of *R. plutonia*, were examined. The tooth count in these specimens is 36–38 rows in the upper jaw, slightly higher than that of *R. plutonia* (32–36; Barnard, 1925), but well below the range for *R. spinacidermis*. Furthermore, the shape of the disc and length of the tail suggest a closer similarity with *R. caudaspinosa*, i.e. a similar relationship between juveniles and adults as in *R. fyllae* (Clark, 1926; Bigelow & Schroeder, 1953). However, until further material becomes available, Norman's (1935) synonymy has been tentatively accepted.

Description

Disc about 1·2–1·4 times as broad as long, its width 1·4–1·5 in total length; obtuse in front with anterior angle in front of spiracles 107°; anterior margins almost straight; posterior margins evenly convex; outer and posterior angles broadly rounded. Axis of greatest breadth 1·4–1·7 times as far from tip of snout as from posterior edge of disc. Tail with well-developed lateral folds on

TABLE 6. *R. spinacidermis*. Measurements expressed as permillage of the total length.

Character	*Type*	♂ (377 mm)	♀ (638·5 mm)
Total length	1 000	1 000	1 000
Disc width	684	660	701
Disc length	515	538	542
Snout to greatest disc width	307	335	315
Snout to middle of vent	466	482	487
Middle of vent to 1st dorsal origin	417	391	379
Snout length	(145)*	166	151
Preoral length	(126)*	166	148
Prenasal length	(106)*	136	114
Eye: longitudinal diameter	33	37	36
Eye and spiracle	42	46	47
Spiracle	20	—	—
Interorbital distance	45	40	36
Interspiracular distance	65	70	64
Internasal distance	83	89	79
Mouth width	83	90	87
Gill slit lengths: 1st	13	15	14
3rd	17	17	16
5th	11	13	10
Distance between inner ends of gill slits:			
1st	130	140	147
5th	89	84	91
1st dorsal fin: height	29	22	22
base length	47	50	48
2nd dorsal fin: height	27	26	19
base length	42	45	55
Interdorsal space	0	0	0

* Measurements made on damaged snout of type specimen.

posterior third; its length from middle of vent to origin of first dorsal fin 1·1–1·3 in length from middle of vent to tip of snout.

Entire upper surface of disc, and upper and lateral surfaces of tail with closely-set, fine, setiform spinules, larger and coarser on tail than elsewhere; enlarged spines or thorns absent on disc and tail in adults, but juveniles with 1–4 enlarged spines before orbit, 0–3 spines behind, and a median row of spines along back and tail, becoming reduced and finally absent in front of first dorsal origin. Enlarged spines are lost with growth (?). Ventral surface with spines on tip of snout and on tail, except on median line of distal two-thirds.

Snout pointed but not produced; its length in front of orbits 3·8–4·2 times as long as distance between orbits; its length in front of mouth 1·5–1·9 times as great as distance between nostrils. Orbits 1·6 times as long as spiracles; distance between orbits 1·0–1·3 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, extending beyond anterior extremities of pectoral rays.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril fringed. Teeth arranged in 54–60 regular rows in upper jaw, blunt with posterior cusp laterally, slightly pointed medially.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins about similar in size and shape, with broadly rounded apices; dorsal fins completely spinulose. First and second dorsals confluent.

Number of vertebrae Vtr 28; Vprd 65; VΣ 93.

Colour

Pale slate grey, becoming slightly darker towards posterior margins of pectorals, and distinctly darker on pelvics. Lower surface similarly and as deeply coloured as upper surface, with white mottling on distal region of tail.

Raja alba Lacépède, 1803

(Pl. 5 A, B; Figs 8 A, B, C)

Raja alba Lacépède, 1803: 663, pl. 20, fig. 1. Norman, 1935: 40. Fowler, 1936: 115; 1941: 365. Van Bruggen, 1965: 190. Hulley, 1966: 497, fig. 8. Wallace, 1967: 27, figs 13–15.

Raia alba: Von Bonde & Swart, 1923: 5. Smith, 1961: 66, fig. 67; 1964: 285. Thorpe, 1964: 27.

Raja marginata Lacépdèe, 1803: 663, pl. 20, fig. 2. Thompson, 1914: 158.

Raia marginata: Regan, 1908: 242. Gilchrist & Thompson, 1916: 285. Barnard, 1925: 65, pl. 4, fig. 1. Clark, 1926: 49, pls 28, 29, 30, 31a. Von Bonde, 1932: 33. Barnard, 1947: 26, pl. 3, figs 11, 11a.

Type

The locality of the types of *R. alba* and *R. marginata* not given in the original description.

Material

21 specimens of both sexes (286–816 mm total length), trawled from False Bay to Port Alfred in 110–183 metres. 9 specimens preserved in the collection of the South African Museum (SAM 3235, 13026, 22578, 22633, 23590, 24329, 24336).

Clark (1926) has shown that *R. marginata* is synonymous with *R. alba*, the common spearnose skate of the north-eastern Atlantic and Mediterranean. This species extends southwards from this region, along the western coasts of Morocco (Pietschmann, 1906), West Africa (Fowler, 1936) and Angola (Franca, 1959) and is reported in South Africa under the same name. Norman (1935) pointed out that the snout appears to be slightly longer in European specimens than in South African specimens, but he was unable to detect any other important difference.

The claspers of a mature male of *R. alba* (1 700 mm total length) in the collection of the Oceanographic Research Institute, Durban, have been examined (fig. 8). The present author is unable to detect a single difference between the structure of the clasper of this specimen and the description of the clasper of European specimens of *R. alba* (Leigh-Sharpe, 1924, fig. 15), and therefore holds that *R. alba* from southern Africa is identical to *R. alba* from the northern hemisphere.

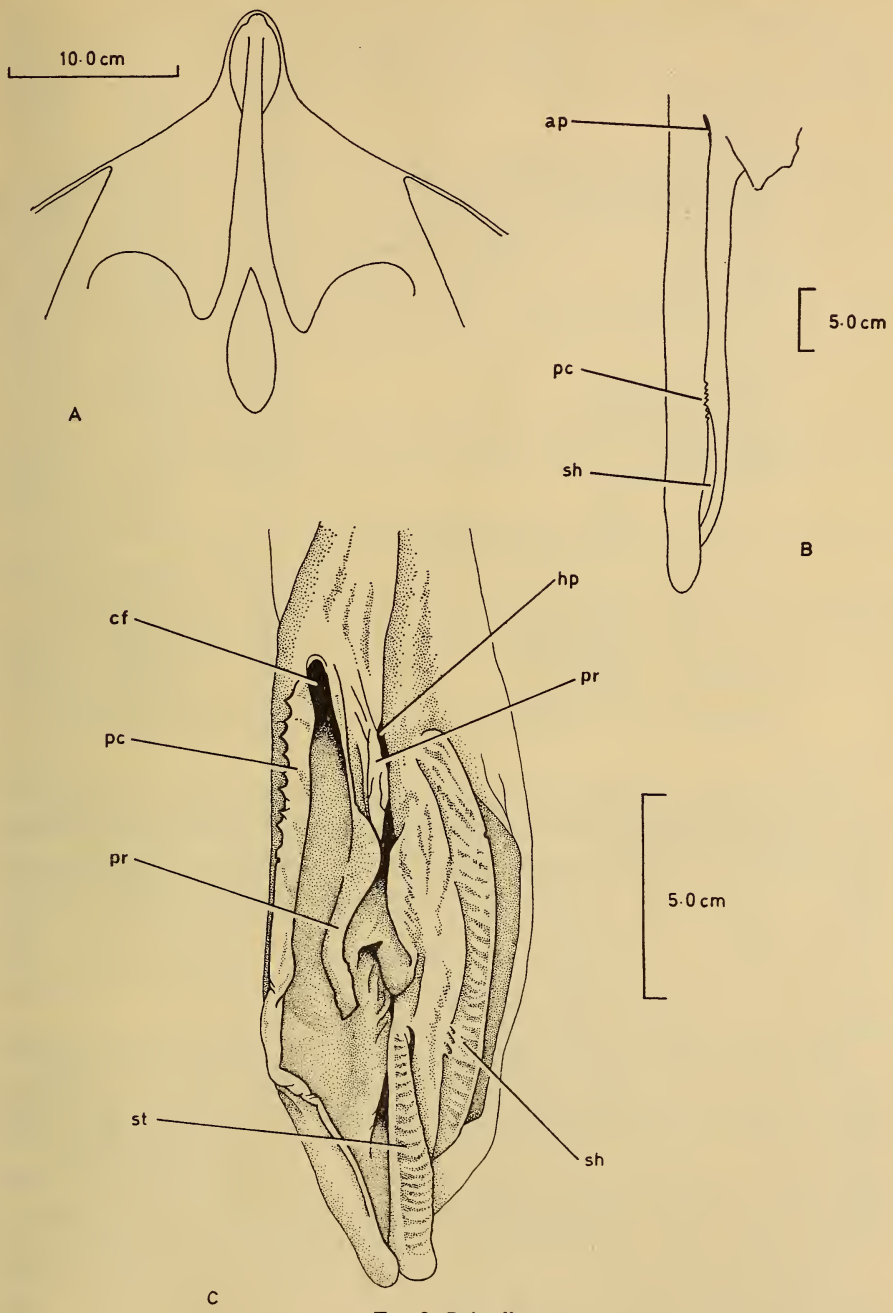


FIG. 8. *Raja alba*.
A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; hp—hypopyle; pc—pecten; 'pr'—'pseudorhipidion'; sh—shield; st—sentinel.

TABLE 7. *R. alba*. Measurements expressed as permillage of the total length. Number of specimens 21.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	777	754–804
Disc length	537	511–566
Snout to greatest disc width	350	300–410
Snout to middle of vent	493	465–516
Middle of vent to 1st dorsal origin	329	314–359
Snout length	155	141–164
Preoral length	149	129–162
Prenasal length	119	103–132
Eye: longitudinal diameter	41	33–47
Eye and spiracle	57	52–61
Spiracle	25	19–35
Interorbital distance	54	49–59
Interspiracular distance	70	63–76
Internasal distance	91	84–97
Mouth width	90	81–101
Gill slit lengths: 1st	18	16–21
3rd	19	16–23
5th	12	10–14
Distance between inner ends of gill slits:		
1st	175	166–186
5th	104	96–109
1st dorsal fin: height	33	27–37
base length	60	50–66
2nd dorsal fin: height	29	20–35
base length	62	56–69
Interdorsal space	17	0–34

Description

Disc about 1·4–1·5 times as broad as long, its width 1·2–1·3 in total length, with maximum angle in front of spiracles about 105°; anterior margins concave just behind tip of snout, convex opposite eyes and again concave opposite spiracles; outer angles pointed, posterior angles broadly rounded. Axis of greatest breadth 1·3–2·2 times as far from tip of snout as from posterior edge of disc. Tail short and broad, tapering posteriorly, with lateral folds well developed on posterior third; its length from middle of vent to first dorsal origin 1·4–1·6 in length from middle of vent to tip of snout.

Juvenile specimens with 1 thorn in front of orbit and 0–1 thorn behind. Nuchal and scapular regions and mid-line of back without thorns. 10–16 thorns along mid-line of tail, from about posterior edge of pelvic to origin of first dorsal, and 0–2 thorns in dorsal interspace. 7–17 lateral caudal thorns in a single row on each side. Otherwise dorsal surface of disc and tail smooth. Ventral surface with spinules on tip of snout, internasal region and anterior margins of disc to about level of mouth; spinules arranged in 3–4 irregular rows.

Adult specimens with a row of thorns about inner margins of orbits. Nuchal and suprascapular thorns absent. 16–30 thorns along mid-line of tail, from about posterior edge of pelvics to origin of first dorsal fin, and 0–2 thorns in dorsal interspace. A single row of 17–29 lateral caudal thorns on each side, irregularly arranged and generally uneven on the two sides. Spinules on dorsal

surface of disc on snout, rostral cartilage, anterior margins and mid-line of back. Ventral surface with spinules on snout, internasal region, anterior margins, abdomen and gill slits. Spinules on both dorsal and ventral surfaces of tail.

Snout abruptly narrowed and produced into a long, sharp point; its length in front of orbits 2·5–3·2 times as long as distance between orbits; its length in front of mouth 1·4–2·4 times as great as distance between nostrils. Orbits 1·4–2·4 times as long as spiracles; distance between orbits 1·2–1·6 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending half the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 40–45 regular rows in upper jaw, with long conical points in middle of jaw, more obtuse with shorter points laterally.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins large, similar in shape with broadly rounded apices; height of first dorsal generally slightly greater than height of second, and base of first shorter than second; interspace between dorsals distinct, 0–58% as long a base of first dorsal.

Number of precaudal vertebrae (Vprd) 62–67.

Colour

Juveniles uniformly brownish, darker towards extremities of pectoral, pelvic and caudal fins. Adults typically grey to brown, with or without scattered white spots. Ventral surface of disc white, tail and margins of pectorals and pelvics brownish to black, especially in juveniles.

Raja miraletus Linnaeus, 1758

(Pl. 7 B; Figs 9 A, B, C)

Raja miraletus Linnaeus, 1758: 231. Thompson, 1914: 158. Fowler, 1936: 114; 1941: 375. Poll, 1949: 190, fig. 4; 1951: 107, fig. 53. Wallace, 1967: 31, figs 16, 17. Hulley, 1969: 137, figs 1–3.

Raia miraletus: Von Bonde & Swart, 1923: 5. Barnard, 1925: 68 (*partim*); 1947: 26. Clark, 1926: 9.

Raja ocellifera: Thompson, 1914: 158. Fowler, 1925: 193. Norman, 1935: 42. Fowler, 1941: 375. Van Bruggen, 1965: 190.

Raia ocellifera Regan, 1906: 2, pl. 2; 1908: 242. Garman, 1913: 365. Gilchrist & Thompson 1916: 286. Von Bonde & Swart, 1923: 5. Barnard, 1925: 67; 1947: 26, pl. 4, fig. 2. Von Bonde, 1933: 32. Smith, 1961: 66, pl. 3, fig. 69; 1964: 285.

? *Raia ocellifera:* Samuel, 1963: 99.

Type

The holotype of *R. ocellifera*, a male (460 mm total length) from Algoa Bay, and paratype, a female (480 mm total length) from Natal in 73 metres, in the collection of the British Museum (Natural History).

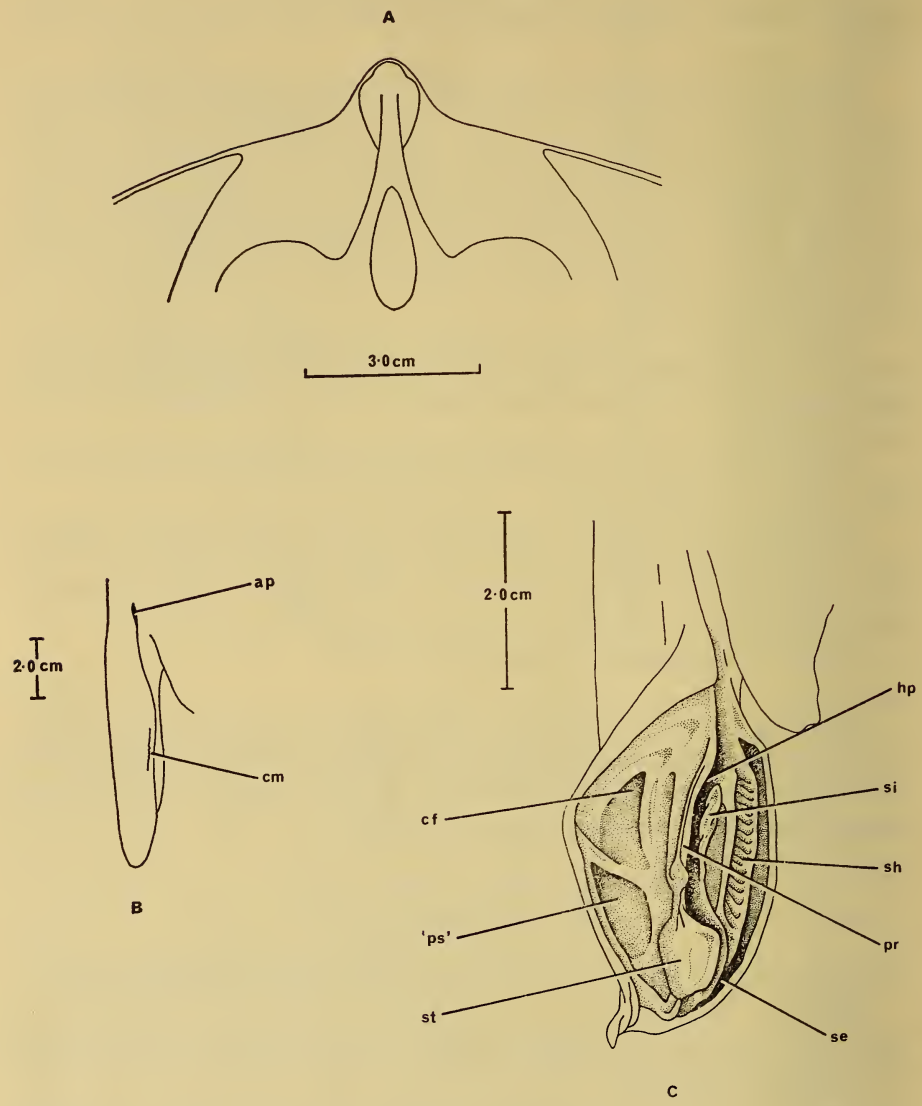


FIG. 9. *Raja miraletus*.

A: rostral bar and rostral appendices.

B: external view of right clasper from the dorsal side.

C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; 'ps'—'pseudosiphon' (pocket); pr—pseudorhipidion; se—sentina; sh—shield; si—signal; st—sentinel.

Material

24 specimens of both sexes (125–510 mm total length), trawled between Cape Agulhas and Natal in 48–78 metres, and 23 specimens (272–504 mm total length) taken by R.V. *Walther Herwig* from 18°30′S to 09°40′S in 100–440 metres. 11 specimens preserved in the collection of the South African Museum (SAM 13022, 13032, 15480, 16228, 16347, 21274, 22789). Three specimens from Angola (Belgian South Atlantic Expedition, Station 15: WNW Banana) and two specimens from Sierra Leone (*Walther Herwig* Station 125/1964) also examined.

Norman (1935) pointed out that *R. ocellifera* Regan from South Africa is closely related to *R. miraletus* Linnaeus from the Mediterranean and the west coasts of Africa, but considered the two to be distinct because of differences in tail length, interorbital distance, tooth count and nature of the ocellus. After comparative morphometric studies on the two species, Wallace (1967: 33) considers 'the variation recorded to be within the limits expected of two geographically separated populations of the same species', and holds that the South African specimens should be referred to *R. miraletus*.

Hulley (1969) agrees with Norman (1935) in that the snout is longer and the interorbital distance narrower in Mediterranean specimens of *R. miraletus* than in South African specimens, but has pointed out that these differences are less noticeable in West African and Angolan specimens when compared with South African specimens. It would appear that these slight differences are of secondary importance in the systematics of this species, as is the small difference in the structure of the ocellus. Furthermore Hulley (1969) has shown that while the tail length is comparatively shorter in West African specimens, the range in number of precaudal vertebrae is the same in the two populations; also there is no difference in tooth count. Comparative anatomical studies of the claspers (Hulley, 1969) have confirmed that *R. ocellifera* is synonymous with *R. miraletus*.

The presence of a bluish-black ocellus at the base of each pectoral fin distinguishes *R. miraletus* from all other South African skates, except some juveniles of *R. clavata*. However, in *R. miraletus* the ocellus is circular (or only very slightly ovate) and consists of three distinct rings of colour, while in *R. clavata* the ocellus is markedly horizontally ovate and is usually composed of a single dark ring enclosing one or two small dark spots.

Description

Disc about 1·3–1·4 times as broad as long, its width 1·4–1·6 in total length; obtuse in front, with anterior angle in front of spiracles 110°–116°; anterior margins weakly concave behind tip of snout and gently concave between level of spiracles and outer corners; outer angles broadly rounded; posterior margins evenly convex. Axis of greatest breadth 0·9–1·3 times as far from tip of snout as from posterior edge of disc. Tail with narrow lateral folds; its length from middle of vent to origin of first dorsal fin 1·1–1·4 in length from middle of vent to tip of snout.

TABLE 8. *R. miraletus*. Measurements expressed as permillage of the total length. Number of specimens 24.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	683	630–724
Disc length	511	477–529
Snout to greatest disc width	263	237–299
Snout to middle of vent	450	420–484
Middle of vent to 1st dorsal origin	350	317–387
Snout length	113	94–136
Preoral length	105	83–127
Prenasal length	84	66–99
Eye: longitudinal diameter	35	29–40
Eye and spiracle	51	45–56
Spiracle	23	19–26
Interorbital distance	43	38–48
Interspiracular distance	62	51–72
Internasal distance	80	68–87
Mouth width	82	67–88
Gill slit lengths: 1st	20	17–23
3rd	20	18–23
5th	14	11–17
Distance between inner ends of gill slits:		
1st	143	130–157
5th	74	62–89
1st dorsal fin: height	24	18–29
base length	56	47–65
2nd dorsal fin: height	24	19–27
base length	59	45–69
Interdorsal space	21	10–28

Juvenile specimens with 2 thorns in front of orbit and 1 behind; 0–2 thorns above spiracles; 3 nuchal thorns; 1 scapular thorn on each side; a row of 18–23 thorns along mid-line of back and tail from scapular region to origin of first dorsal and 0–2 thorns in dorsal interspace. Sometimes a few small spines situated semi-laterally on tail, otherwise dorsal and ventral surfaces smooth.

Older specimens show an increase in the number of thorns around orbits and on tail, but a reduction (to complete loss) of thorns along mid-line of back and on scapular region. Adults typically with 4–8 thorns around inner margins of orbits; 0–2 median nuchal thorns; a row of 12–27 thorns along mid-line of tail, from above axils of pelvics to first dorsal origin, and 1–2 thorns in dorsal interspace. Lateral rows of thorns on tail in 1–2 rows, generally unequal in number on the two sides and ranging from 8–16 thorns in semi-lateral rows and 0–13 in lateral rows. Dorsal surface with spinules on snout, anterior margins to level of spiracles, mid-line of back, and some specimens with a small group of stellate-based spines on posterior pectoral angle. Ventral surface with spines on snout, internasal region and anterior margins of disc to about level of nostrils.

Snout obtuse and not produced; its length in front of orbits 2·3–3·1 times as long as distance between orbits; its length in front of mouth 1·1–1·5 times

as great as distance between nostrils. Orbits 1·2–1·8 times as long as spiracles; distance between orbits 1·1–1·4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending about two thirds the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 42–50 rows in upper jaw, usually with a single median point in middle of jaw, more obtuse with shorter points laterally.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape and about equal in size; interspace between dorsals usually small but distinct, up to 66% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 47–52. Krefft (1968*a*) gives the following count for *R. miraletus*: Vtr 25–29; Vprd 44–52; VΣ 70–81.

Colour

Brownish, with or without numerous small darker spots; a large blue-black ocellus at the base of each pectoral, consisting of three definite rings of colour. Ventral surface pale, with or without a small dark spot on tip of snout.

Raja clavata Linnaeus, 1758

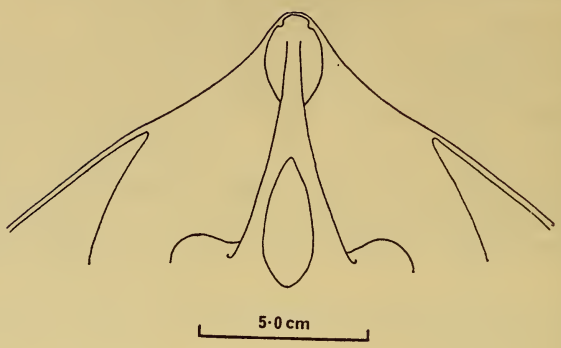
(Pl. 6A; Figs 10 A, B, C)

Raja clavata Linnaeus, 1758: 232. Gilchrist, 1922: 7. Fowler, 1936: 110; 1941: 360. Poll, 1949: 188, fig. 3. Hulley, 1966: 497, figs 1–3. Wallace, 1967: 35, figs 18, 19.
Raia clavata: Barnard, 1925: 64, pl. 4, fig. 2; 1947: 26, pl. 4, fig. 1. Von Bonde, 1933: 32.
Raja rhizacanthus: Thompson, 1914: 158. Norman, 1935: 40. Smith & Smith, 1966: 29, fig.
Raia rhizacanthus Regan, 1906: 3, pl. 3; 1908: 242. Gilchrist & Thompson, 1916: 286. Von Bonde & Swart, 1923: 5. Smith, 1961: 67, pl. 3, fig. 71.
Raja capensis Müller & Henle, 1841: 151. Gray, 1851: 112. Bleeker, 1860: 58. Duméril, 1865: 540, pl. 12, figs 11, 12. Kner, 1865: 419. Gilchrist, 1902: 168. Thompson, 1914: 157. Gilchrist, 1921: 27.
Raia capensis: Sauvage, 1891: 510. Von Bonde & Swart, 1923: 4.
Raia barnardi: Smith, 1961: 67, pl. 3, fig. 70.
? *Raja maculata:* Bleeker, 1860: 58. Gilchrist, 1902: 168. Thompson, 1914: 157.
? *Raia maculata:* Barnard, 1925: 71. Von Bonde, 1933: 32.
? *Raia oculata:* Von Bonde & Swart, 1923: 4.

Types

The holotype of *R. rhizacanthus*, a juvenile male (210 mm total length), from the coast of Natal in 73 metres, in the collection of the British Museum (Natural History).

The paratype of *R. capensis* in the collection of the Muséum National d'Histoire Naturelle, Paris.



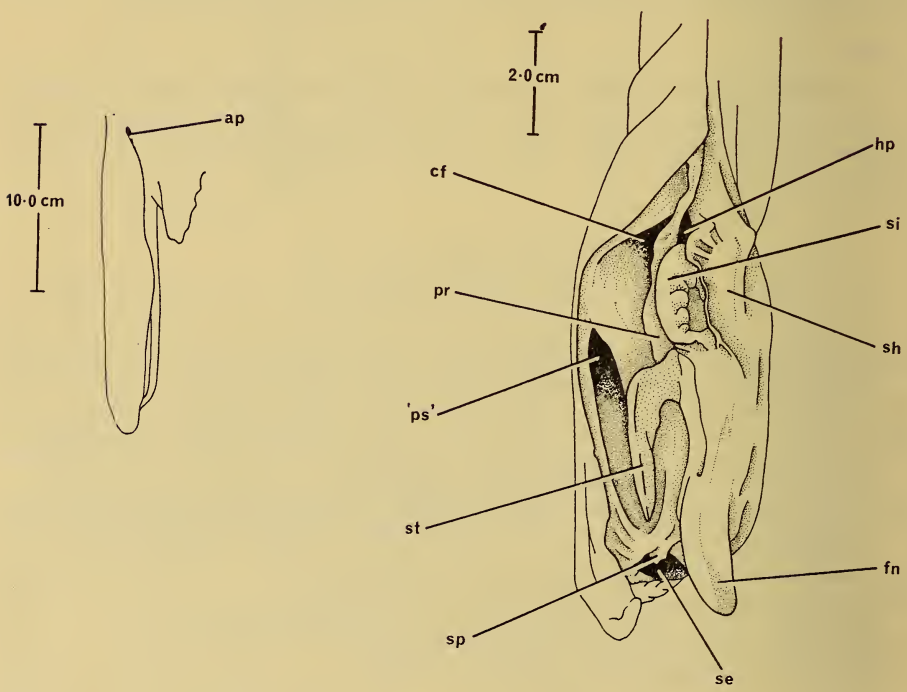


Fig. 10. *Raja clavata.*

A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; fn—funnel; hp—hypopyle; pr—pseudorhipidion; 'ps'—'pseudosiphon' (pocket); se—sentina; si—signal; sh—shield; sp—spike; st—sentinel.

Material

41 specimens of both sexes (171–790 mm total length), trawled between Cape Columbine and Algoa Bay in 55–548 metres. 30 specimens preserved in the collection of the South African Museum (SAM 22786–8, 23006–8, 24324–8, 24330–5, 24337–8, 24355–60, 24534–40).

Although the South African species *R. rhizacanthus* Regan was previously thought to be distinct from the European 'thorn-back' skate *R. clavata* Linnaeus because of differences in the spination and in the position of the vent (Norman, 1935), several authors (Barnard, 1925; Fowler, 1936, 1941) considered the two to be synonymous. Comparative anatomical studies of the claspers (Hulley, 1966) and detailed morphometric measurements (Wallace, 1967) have confirmed that the South African specimens should be referred to *R. clavata*.

R. herwigi, *R. maderensis*, *R. straeleni* and *R. clavata* form a definite sub-group of the genus *Raja* but at present the systematics of this complex of species is uncertain. *R. clavata* closely resembles *R. straeleni* in proportional dimensions, tooth count and number of vertebrae, but differs from this species in its intensity and pattern of coloration, the degree of development of the shield in the clasper glans and in its distribution. In the South Atlantic, *R. clavata* appears to have a northern limit at 26° and is replaced by *R. straeleni* over the area 22°S to 0°.

Adult specimens can easily be recognized by the spinulose nature of the dorsal surface of the disc and by the presence of enlarged buckler-like thorns, especially in females (these thorns are absent in *R. straeleni*). Adults resemble *B. smithii* in shape, but may be distinguished from this species by the number of rows of teeth in the upper jaw, the structure of the rostral cartilage and rostral appendices, and by the presence in *R. clavata* of lateral rows of thorns on the tail. It should be noted that the dental formula for *R. clavata* given by Wallace (1967) as 23–26 rows in the upper jaw, is inconsistent with previous investigations: Regan (1906) reported 36 rows in the type, Barnard (1925) gave 38–44 and Norman (1935) 36–44 rows. In the specimens examined by the author, the range was found to be 36–45, which corresponds with the 36–44 rows in European specimens (Clark, 1926). Juvenile specimens of *R. clavata* are generally smooth (sometimes with spinules along the anterior margins of the disc) and lack a lateral series of thorns on the tail. These facts, together with the lack of a produced and pointed snout and a tooth count of more than 30 rows in the upper jaw, separate this species from all other known South African skates, except *R. miraletus*. However, *R. miraletus* possesses ocelli on the dorsal surface of the disc.

Some juveniles of *R. clavata* possess a pair of ocelli at the bases of the pectoral fins, which may lead to confusion with *R. miraletus*. In *R. miraletus*, however, the ocellus is circular (or only very slightly ovate) and consists of three definite rings of colour, while in *R. clavata*, the ocellus is markedly horizontally ovate and is usually composed of a single dark ring, within which are two (sometimes one) darker spots.

TABLE 9. *R. clavata*. Measurements expressed as permillage of the total length. Number of specimens 41.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	731	679–773
Disc length	529	481–569
Snout to greatest disc width	308	280–336
Snout to middle of vent	471	432–517
Middle of vent to 1st dorsal origin	349	317–390
Snout length	133	120–155
Preoral length	123	106–142
Prenasal length	102	87–119
Eye: longitudinal diameter	35	23–41
Eye and spiracle	49	45–56
Spiracle	23	19–27
Interorbital distance	47	41–52
Interspiracular distance	70	65–75
Internasal distance	84	76–92
Mouth width	82	77–91
Gill slit lengths: 1st	20	
3rd	21	
5th	14	
Distance between inner ends of gill slits:		
1st	159	135–177
5th	83	73–97
1st dorsal fin: height	29	19–39
base length	58	45–71
2nd dorsal fin: height	30	21–37
base length	60	45–76
Interdorsal space	19	0–35

Description

Disc about 1·3–1·4 times as broad as long, its width 1·3–1·5 in total length; obtuse in front, with anterior angle in front of spiracles 80°–100°; anterior margins weakly concave behind tip of snout and again at level of spiracles, more deeply so in males than in females; outer and posterior angles broadly rounded. Axis of greatest breadth 1·2–1·8 times as far from tip of snout as from posterior edge of disc. Tail with moderately developed lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1·2–1·6 in length from middle of vent to tip of snout.

Juvenile specimens with 2 thorns in front of orbits and 1 behind: 1 supraspiracular thorn and 1 pair of thorns between spiracles; 2–4 median nuchal thorns; 2 scapular thorns on each side; a row of 24–30 thorns along mid-line of back and tail from scapular region to origin of first dorsal fin; 1–2 thorns in dorsal interspace. No lateral rows of thorns on tail. Dorsal surface with spinules on snout, interorbit, anterior margins of disc and along mid-dorsal region of back and tail. Ventral surface smooth.

Older specimens show a reduction in number of preorbital, postorbital, supraspiracular, interspiracular and scapular thorns, until these disappear in the adult. Adults typically with no thorns around inner margins of orbits and above spiracles, no nuchal spines, no scapular thorns and no enlarged thorns

along the mid-line of back; a row of 19–41 thorns along mid-line of tail from above vent to origin of first dorsal fin; 1–2 thorns in dorsal interspace. A row of lateral caudal thorns on each side (sometimes two), irregularly arranged. Widely-spaced spinules on dorsal surface of snout, interorbit and mid-dorsal region of back and tail. Ventral surface spinulose along anterior margins of disc and around vent. Buckler-like thorns on dorsal and ventral surfaces of disc, especially around vent, in some specimens, particularly females.

Snout pointed but not produced; its length in front of orbits 2·6–3·4 times as long as distance between orbits; its length in front of mouth 1·3–1·7 times as great as distance between nostrils. Orbits 1·3–2·0 times as long as spiracles; distance between orbits 1·1–1·4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; tips of pectoral fins falling short of appendices.

Mouth slightly arched; nasal curtain slightly fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 36–45 rows in upper jaw, with large cusp in sexually mature males, but blunt and flat in juveniles and females.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape, with broadly rounded apices; first dorsal usually slightly smaller than second; interspace between dorsals usually about 30% as long as base of first dorsal, but varying between 0% and 66%.

Number of precaudal vertebrae (Vprd) 45–53.

Colour

Colour variable, particularly in juveniles. Brownish or grey-brown, with or without numerous irregular darker and lighter spots or with larger irregular darker blotches. Juveniles generally with a dark, horizontally ovate ocellus at the base of each pectoral, consisting of a single dark ring enclosing two (sometimes one) dark spots. Ventral surface pale, margins of pectorals generally greyish, occasionally with some darker irregular patches.

Raja straeleni Poll, 1951

(Pl. 6 B; Figs 11 A, B, C)

Raja straeleni Poll, 1951: 118, fig. 54. Krefft, 1968*a*: 66, pl. Va.

Types

The holotype, a mature male (620 mm total length), trawled in 100–110 metres at 13°05′S, 12°46′E, in the collection of the Institut Royal des Sciences Naturelles, Brussels. 21 paratypes in the same collection.

Material

The holotype and paratypes, as well as 8 specimens trawled in 200–700 metres by R.V. *Walther Herwig* between 10°28′S and 22°03′S. Measurements taken on 16 specimens including the holotype. Material from the R.V. *Walther Herwig* located in the collection of the Institut für Seefischerei, Hamburg.

R. straeleni forms part of the *clavata*-complex of species. The systematics of this complex, which includes the species *R. clavata*, *R. herwigi*, *R. maderensis* and *R. straeleni* is as yet uncertain. In the South Atlantic, *R. straeleni* has been found in the region between the equator and about 22°S and is replaced by *R. clavata* to the south of this limit.

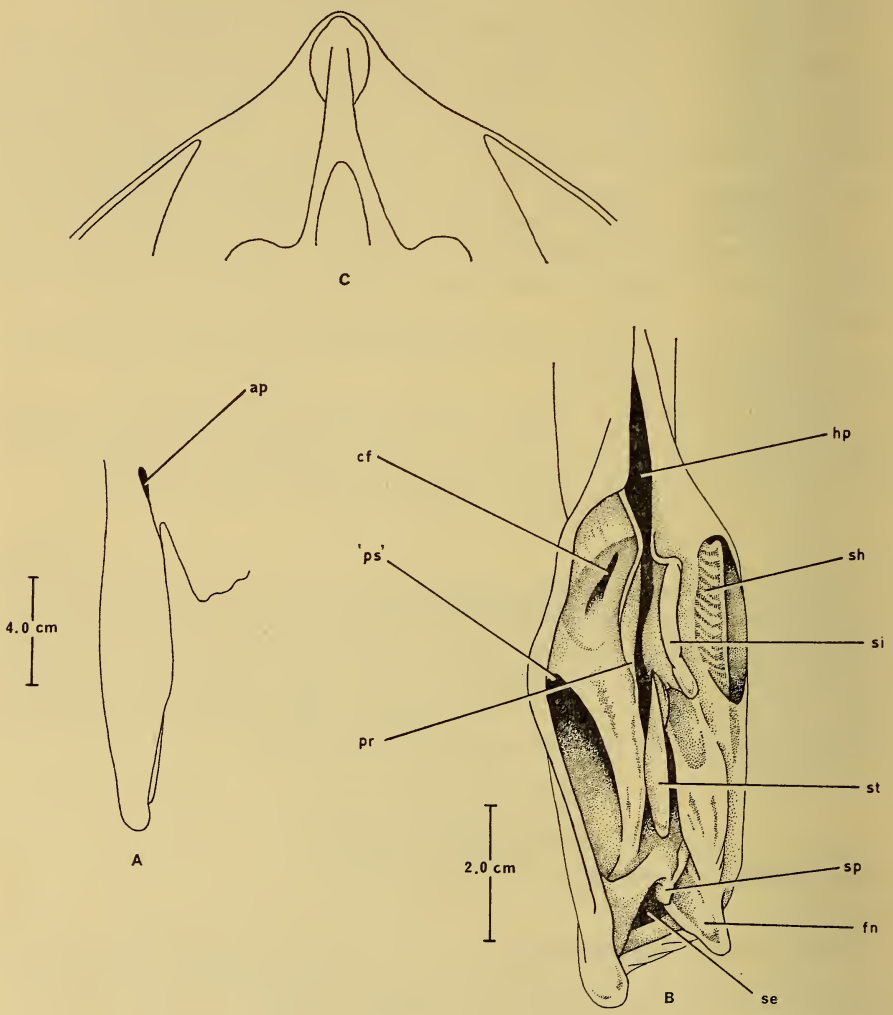


FIG. 11. *Raja straeleni.*

A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; fn—funnel; hp—hypopyle; pr—pseudorhipidion; 'ps'—'pseudosiphon' (pocket); se—sentina; sh—shield; si—signal; sp—spike; st—sentinel.

R. straeleni very closely resembles *R. clavata*, and while there are noticeable differences in colour pattern and intensity, which appear to be constant in *R. straeleni*, there is only a slight difference in the external morphology of the claspers of the two species – the shield in *R. straeleni* is more strongly developed, suggesting a difference in the degree of development of the ventral terminal cartilage. Morphometric proportions and vertebral counts are similar in the two species.

On the basis of colour pattern, the taxonomic significance of which is at present unknown, distribution and the structure of the shield, *R. straeleni* has been retained for the moment as a separate species. Detailed investigations of the skull and the nature of the clasper cartilages should elucidate this problem.

TABLE 10. *R. straeleni*. Measurements expressed as permillage of the total length. Number of specimens 16.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	672	614–729
Disc length	503	471–525
Snout to greatest disc width	322	292–357
Snout to middle of vent	465	439–500
Middle of vent to 1st dorsal origin	343	326–383
Snout length	132	124–144
Preoral length	125	112–135
Prenasal length	102	93–109
Eye: longitudinal diameter	40	33–49
Eye and spiracle	55	48–60
Interorbital distance	44	40–48
Interspiracular distance	69	63–72
Internasal distance	88	84–92
Mouth width	86	81–94
Gill slit lengths: 1st	21	17–28
3rd	23	17–28
5th	16	14–22
Distance between inner ends of gill slits:		
1st	163	150–180
5th	83	69–90
1st dorsal fin: height	29	22–34
base length	61	54–70
2nd dorsal fin: height	27	23–32
base length	60	55–70
Interdorsal space	34	27–56

Description

Disc about 1·2–1·5 times as broad as long, its width 1·4–1·7 in total length; obtuse in front, with anterior angle in front of spiracles about 95°–100°; anterior margins weakly concave behind tip of snout and again at level of spiracles; outer angles rounded, posterior margins evenly convex. Axis of greatest breadth 1·5–2·0 times as far from tip of snout as from posterior edge of disc. Tail with lateral folds on posterior half; its length from middle of vent to origin of first dorsal fin 1·2–1·5 in length from middle of vent to tip of snout.

1–2 thorns in front of orbits and 1–3 behind; 0–1 thorn above each spiracle;

4–5 median nuchal thorns; 0–2 scapular thorns; a row of 20–52 thorns along mid-line of back and tail, from about axis of greatest breadth to first dorsal origin; 0–6 thorns in dorsal interspace. A few lateral thorns on anterior region of tail, becoming regularly arranged and hook-like posteriorly. Dorsal surface in males entirely covered with small spines, but in females spinules only on tip of snout, mid-dorsal region of back and tail, and anterior margins of disc. Ventral surface with spines on tip of snout and along anterior margins of disc; otherwise smooth.

Snout pointed but not produced; its length in front of orbits 2·8–3·2 times as long as distance between orbits; its length in front of mouth 1·3–1·5 times as great as distance between nostrils. Distance between orbits 0·8–1·4 times as great as length of orbit.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 36–45 (35–42: Poll, 1951) rows in upper jaw, blunt and flat in smaller specimens, but sharp-pointed in adult males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape with broadly rounded apices; first dorsal usually smaller than second; interspace between dorsals 17%–104% as long as base of first dorsal.

Vertebral count: Vtr 24–28; Vprd 48–52; VΣ 73–78 (Krefft, 1968*a*).

Colour

Dorsal surface brown to grey with numerous dark spots on whole of disc except snout, pelvic fins and tail; spots regularly arranged. Ventral surface of disc pale or mottled grey, sometimes with a darker margin along posterior edges of pectorals and pelvics. Krefft (1968*a*) reports that in juveniles there is no evidence of darker spots on the dorsal surface.

Raja robertsi n.sp.

(Pl. 8 A, B; Figs 12 A, B)

Type

A juvenile male (773 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 196/67: 33°51′S, 17°14′E) in 1350 metres, in the collection of the Institut für Seefischerei, Hamburg.

Material

A single specimen, the holotype.

This species forms part of the *radiata*-group, the distribution and interrelationships of which have been discussed by Krefft (1968*b*). The group is characterized by a lozenge-shaped disc, short tail and by the presence of a single mid-dorsal row of stout spines, extending from the nuchal region (in some species from the axils of the pelvics) to the origin of the first dorsal fin. Preliminary

examination of the claspers of this group of species has revealed the presence of a pseudosiphon in the outer dorsal wall of the clasper glans. Although the type of *R. robertsi* is a juvenile male (clasper length 61 mm), the existence of the pseudosiphon can already be detected in the still undeveloped clasper.

In the Atlantic, at least, the *radiata*-group appears to be divisible into two sub-groups: the heavily-spined species, comprising the North–South Atlantic pairs *R. radiata*—*R. doellojuradoi* and *R. hyperborea*—*R. frerichsi*: and the sub-group comprising the North Atlantic species *R. jenseni* and the South Atlantic species *R. georgiana*, in which there are no enlarged stellate-based thorns on the anterior margins and posterior angles of the pectorals. *R. robertsi* is a member of this second sub-group.

Although it resembles *R. georgiana* in tooth count and spination of the orbit, *R. robertsi* can easily be separated from this species by the characteristic dark coloration of its ventral surface. It most closely approximates to the North Atlantic species *R. jenseni* in lacking large rostral thorns and in ventral coloration, but differs markedly from this species in tooth count (56–66 rows in upper jaw in *R. jenseni* (Bigelow & Schroeder, 1953): 42 rows in *R. robertsi*), preoral length and scapular spination. Furthermore, there are fewer thorns in the mid-line of the disc and tail in *R. robertsi*.

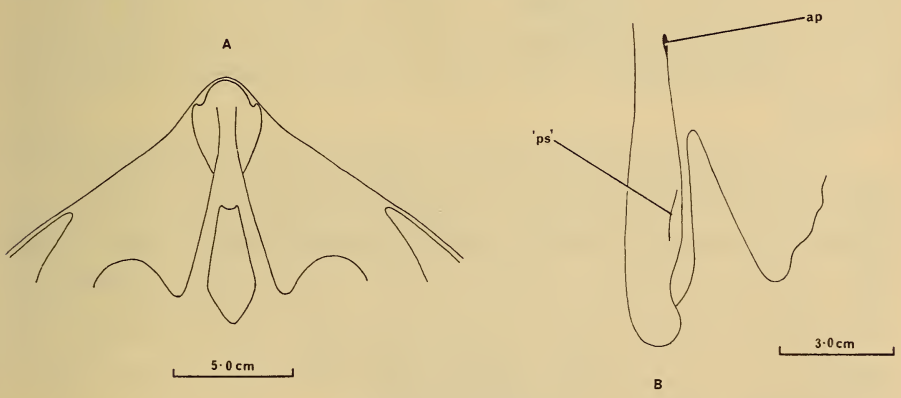


Fig. 12. *Raja robertsi*.
A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
ap—apopyle; 'ps'—'pseudosiphon'.

In tooth count and general coloration, *R. robertsi* falls close to *R. badia* caught in 1270 fathoms in the Gulf of Panama (Garman, 1899). However, *R. badia* belongs to the heavily spined sub-group (Berg, 1911 considers it to be a possible synonym of *R. hyperborea* (Bigelow & Schroeder, 1953)) and therefore differs in the spination of the disc.

This species has been named in honour of Mr. J. Douglas Roberts, who by his kind generosity, made the study of the *Walther Herwig* material in Hamburg possible.

TABLE 11. *R. robertsi.* Measurements expressed as permillage of the total length. A single specimen, the type (773 mm total length).

Character	*Dimensions*
Total length	1 000
Disc width	729
Disc length	569
Snout to greatest disc width	428
Snout to middle of vent	581
Middle of vent to 1st dorsal origin	311
Snout length	145
Preoral length	142
Prenasal length	108
Eye: longitudinal diameter	44
Eye and spiracle	63
Interorbital distance	68
Interspiracular distance	107
Internasal distance	121
Mouth width	131
Gill slit lengths: 1st	15
3rd	14
5th	11
Distance between inner ends of gill slits:	
1st	215
5th	155
1st dorsal fin: height	17
base length	45
2nd dorsal fin: height	15
base length	40
Interdorsal space	0

Description

Disc 1·3 times as broad as long, its width 1·4 in total length; obtuse in front, with anterior angle in front of spiracles 96°: anterior margins concave just behind tip of snout and more deeply concave just posterior to level of spiracles; outer angles somewhat pointed, posterior margins almost straight. Axis of greatest breadth 3·4 times as far from tip of snout as from posterior edge of disc. Tail with fairly well developed lateral folds along its entire length; its length from middle of vent to origin of first dorsal fin 1·9 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1·4 in length from middle of vent to tip of snout.

Spination:

Preorbital thorns	1/1
Postorbital thorns	1/1
Supraspiracular thorns	1/1
Median nuchal thorns	2
Scapular thorns	2/2

A single row of 21 (+ 1 scar) stout thorns extending from nuchal region almost to origin of first dorsal. No lateral rows of thorns on disc or tail. 1 small stellate-based spine on rostrum, no thorns on anterior margins and posterior angles of pectorals; entire upper surface of disc and tail covered with close-set spinules. Malar spines present. Ventral surface of disc and tail smooth.

Snout obtuse and not produced; its length in front of orbits 2·4 times as long as distance between orbits; its length in front of mouth 1·2 times as great as distance between nostrils. Distance between orbits 1·5 times as great as length of orbit. Rostral cartilage extending from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending half the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril fringed; no barbel-like lobe on inner edge of each nostril, but a slight fleshy fold present. Teeth arranged in 42 regular rows in upper jaw, with round bases and large, sharp posterior cusps.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsals more or less similar in size with convex anterior margins and rounded apices; first dorsal continuous with second.

Vertebral count: Vtr 32, Vprd 55, VΣ 87.

Colour

Dorsal surface of disc greyish with a few scattered darker patches over disc and tail; pelvics somewhat darker. Ventral surface of disc uniformly grey to black, tending to be darker at posterior margins of pectorals, tips of anterior lobes of pelvics and on tail. A white inverted-triangular patch in median position, with base line on level of pectoral girdle. Lower jaw and area about nostrils white.

Clasper structure

The type is an immature male, in which definite structures in the clasper glans cannot be identified. However, the claspers are of the short, spatulate variety and a pseudosiphon can be distinguished in the outer dorsal surface of the glans (fig. 12).

Raja radiata Donovan, 1807

(Pl. 7 A; Fig. 13)

Raja radiata Donovan, 1807: pl. 114.

Material

Two specimens, a male (573 mm total length) and a female (616 mm total length), trawled west of Cape Town in 548–640 metres. Both specimens preserved in the collection of the South African Museum.

This species represents a new record for the eastern South Atlantic. *R. radiata* is retained in the genus *Raja* because of the structure of the snout and a precaudal vertebral count of 58–62. It can easily be distinguished from all other South African species, except *R. robertsi*, by its extremely short tail, and differs from *R. robertsi* in the heavy spination of the disc and tail.

R. radiata forms part of the *radiata*-group of species, which are charac-

terized by their lozenge-shaped disc, short tail and single mid-dorsal row of stout thorns. The distribution and interrelationships of this group have been discussed by Krefft (1968*b*).

In appearance and type of spination, *R. radiata* falls into the heavily-spined sub-group of the *radiata*-complex. *R. radiata* is so closely allied to *R. doellojuradoi*, recorded from the western South Atlantic, that Bigelow & Schroeder (1953: 255) point out that 'no reliable criteria have been found to distinguish the one from the other'. Pozzi (1935, 1936) and Norman (1937) hold that in *R. radiata* the tail is longer, so that the vent is nearer to the tip of the snout than to the end of the tail; the teeth are more numerous (38–46 rows in upper jaw in *R. radiata*; 31–34 rows in *R. doellojuradoi*); there are only 2 scapular thorns; and the spines on the disc are less well developed, there being less than 10 in the mid-line of the tail posterior to the axils of the pelvics. Krefft (personal communication), in comparing six specimens of *R. radiata* from the northern Atlantic with five specimens of *R. doellojuradoi* from the western South Atlantic, has found that there is no difference in the number and distribution of the median thorns and no difference in spination except in the number of scapular thorns. Whereas in *R. radiata* two large scapular thorns exist, the third one being either vestigial or much smaller than the outer ones, in *R. doellojuradoi* the three scapular thorns are of the same size.

In the South African specimens, tooth count favours their identity with *R. radiata*, and while size at first maturity may be a questionable taxonomic character, the size of the two specimens is well above the 530 mm total length limit for *R. doellojuradoi* (Krefft, personal communication). Furthermore the rajid distribution of the Atlantic suggests that the South African fauna, which

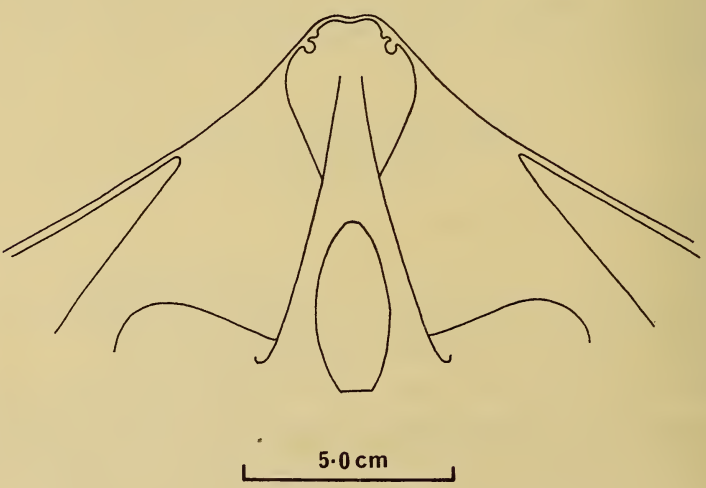


Fig. 13. *Raja radiata.*
Rostral bar and rostral appendices.

contains a number of European species (Hulley, 1966; 1969) is more closely related to that of the North Atlantic than to that of South America, i.e. a distribution following the continental slopes from north to south seems more feasible than an east–west distribution, which presupposes a crossing of the deep-sea plane or a very old 'Gondwanaland' distribution. This seems all the more likely since the generic and specific composition of the skate fauna of the eastern South Atlantic differs markedly from that of the western South Atlantic.

TABLE 12. *R. radiata*. Measurements expressed as permillage of the total length. Number of specimens 2.

Character	*Male*	*Female*
Total length	1 000	1 000
Disc width	764	771
Disc length	595	566
Snout to greatest disc width	405	360
Snout to middle of vent	597	575
Middle of vent to 1st dorsal origin	311	326
Snout length	156	149
Preoral length	152	148
Prenasal length	119	112
Eye: longitudinal diameter	42	33
Eye and spiracle	60	54
Spiracle	30	27
Interorbital distance	65	72
Interspiracular distance	101	101
Internasal	117	111
Mouth width	120	112
Gill slit lengths: 1st	13	12
3rd	17	16
5th	9	9
Distance between inner ends of gill slits:		
1st	213	205
5th	114	142
1st dorsal fin: height	23	21
base length	40	36
2nd dorsal fin: height	20	19
base length	43	41
Interdorsal space	6	8

Description

Disc about 1·2–1·3 times as broad as long, its width 1·3 in total length; obtuse in front, with anterior angle in front of spiracles about 100°; anterior margins slightly concave close behind tip of snout, otherwise almost straight; posterior angles much more broadly rounded than outer angles. Axis of greatest breadth 1·7–2·1 times as far from tip of snout as from posterior edge of disc. Tail with well-developed lateral folds beginning at axils of pelvics; its length from middle of vent to origin of first dorsal fin 1·8 –1·9 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1·4–1·5 in length from middle of vent to tip of snout.

Upper surface of disc with a median row of 18 large, conspicuous thorns on radiate bases, extending from nuchal region to origin of first dorsal; 5–6 of these anterior to axils of pelvics, and 13–14 laterally compressed thorns from

axils of pelvics to origin of first dorsal, decreasing in size posteriorly. Mid-line of back with 2–3 irregular rows of smaller thorns on stellate bases on either side of the mid-dorsal row, extending almost from the nuchal region to first dorsal origin, becoming sharper and recurved posteriorly; small spines in dorsal interspace. Anterior, median and posterior areas of pectorals with scattered thorns and smaller spines; thorns present on rostral projection, interorbit and interspiracular regions and on sides of tail; naked areas confined to anterior parts of pelvics. 1 large thorn in front of orbit and 1 behind; 1 thorn directly above each spiracle, close to postorbital thorn; 2 nuchal thorns in mid-line; 2–3 scapular thorns, the third vestigial. Ventral surface of disc and tail completely smooth.

Snout obtuse and not produced; its length in front of orbits 2·1–2·4 times as long as distance between orbits; its length in front of mouth 1·3 times as great as distance between nostrils. Orbits 1·2–1·4 times as long as spiracles; distance between orbits 1·6–2·2 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; anterior rays of pectorals extending two-thirds the distance forward from level of front of orbits towards tip of snout.

Mouth slightly arched, more so in the male than in the female; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 37–39 regular rows in upper jaw, with round bases and large, sharp posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsals similar in shape and about similar in size, with convex anterior margins and broadly rounded apices; interspace between dorsals 14–23% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 58–62.

Colour

Upper surface brownish-grey, with scattered irregular black blotches, especially on anterior limb of pelvic fin. Ventral surface white, with darker spots and blotches on tail and pelvics, and black spot on tip of tail.

Raja ravidula n. sp.

(Pl. 9 A, B; Fig. 14)

Types

The holotype, a juvenile male (634·5 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 195/76: 33°49′S, 17°13′E) in 1 000 metres, in the collection of the Institut für Seefischerei, Hamburg. The paratypes, a juvenile male (605 mm total length) and a juvenile female (631·5 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 194/67: 33°47′S, 17°14′E) in 1 000 metres, in the same collection.

Material

The holotype and paratypes.

This species of deep-water skate differs from all known South African species with less than 50 rows of teeth in the upper jaw in that a median row of thorns along the back and tail is absent. In lacking a median row of thorns it approximates to the European species *R. fullonica*, which has been recorded as far south as Morocco (Murray & Hjort, 1912). However, it may be distinguished from this species by its lower tooth count (39–44 rows in upper jaw in *R. ravidula*; 58–68 rows in *R. fullonica*), lack of thorns on the tip of the rostrum and by the number and arrangement of the nuchal spines.

TABLE 13. *R. ravidula*. Measurements expressed as permillage of the total length.

Character	*Type* ♂	*Paratype* ♂	*Paratype* ♀
Total length	1 000	1 000	1 000
Disc width	561	578	570
Disc length	489	505	482
Snout to greatest disc width	291	314	312
Snout to middle of vent	491	496	487
Middle of vent to 1st dorsal origin	384	391	403
Snout length	138	142	148
Preoral length	149	147	155
Prenasal length	126	126	133
Eye: longitudinal diameter	38	38	38
Eye and spiracle	50	50	49
Interorbital distance	32	30	30
Interspiracular distance	72	71	71
Internasal distance	82	84	84
Mouth width	72	83	71
Gill slit lengths: 1st	14	15	13
3rd	15	18	14
5th	11	12	11
Distance between inner ends of gill slits:			
1st	132	131	138
5th	90	87	91
1st dorsal fin: height	29	31	33
base length	48	50	43
2nd dorsal fin: height	27	25	34
base length	48	45	50
Interdorsal space	8	0	0

Description

Disc about 1·1–1·2 times as broad as long, its width 1·7–1·8 in total length; maximum anterior angle in front of spiracles about 92°; anterior margins weakly concave behind tip of snout and again at level of spiracles; outer and posterior angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1·5–1·8 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1·2–1·3 in length from middle of vent to tip of snout.

No thorns along mid-line of back and tail (paratype with 1 small thorn in mid-line at about half tail length). A single series of thorns on each side of mid-line, extending from nuchal region to first dorsal origin, widely spaced on back, but, close-set and larger on tail. No thorns on rostral cartilage or between dorsal fins. Entire dorsal surface of disc covered with blunt, flat, widely-spaced asperities, tail with larger and more pointed spinules. Ventral surface of disc and tail smooth.

Snout pointed and a little produced; its length in front of orbits 4·3–4·8 times as long as distance between orbits; its length in front of mouth 1·8 times as great as distance between nostrils. Distance between orbits 1·2–1·3 in length of orbit. Rostral cartilage projecting from cranium as hard bar, with rostral appendices fused to bar throughout their length; tips of pectoral rays falling short of appendices.

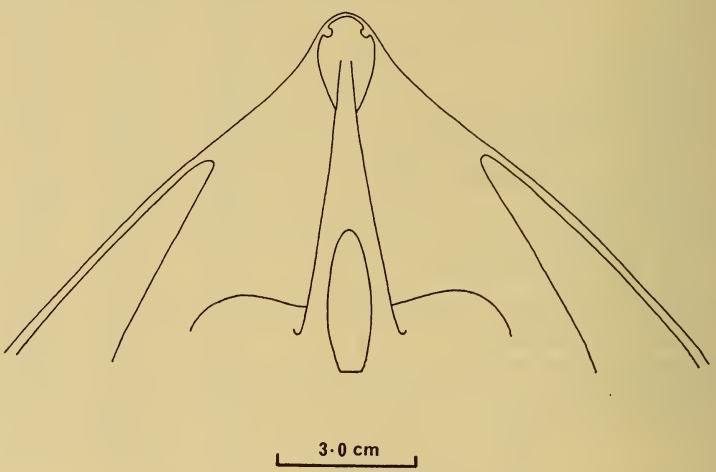


Fig. 14. *Raja ravidula*.
Rostral bar and rostral appendices.

Spination	*Holotype* ♂	*Paratype* ♂	*Paratype* ♀
Preorbital thorns . . .	3/3	4/4	3/3
Postorbital thorns . . .	3/3	3/3	3/3
Supraspiracular thorns . . .	1/1	1/1	1/1
Interspiracular thorns . . .	1/0	0/0	0/1
Median nuchal thorns . .	6	6	6
Lateral nuchal thorns . . .	4/3+2	4/4	2+3/2+2
Scapular thorns	2/2	0/1	3/2

Mouth slightly arched; nasal curtain slightly fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 39–44 rows in upper jaw, blunt and flat with small posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected to posterior lobes along outer margin of fin.

Dorsals similar in shape, with broadly rounded apices; first dorsal usually slightly larger than second; interspace between dorsals 0%–16·5% as long as base of first dorsal.

Vertebral count	*Holotype* ♂	*Paratype* ♂	*Paratype* ♀
Vtr	33	30	30
Vprd	69	69	70
VΣ	102	99	100

Colour

Dorsal surface of disc pale grey, becoming darker along posterior margins of pectorals and pelvics and at distal end of tail. Ventral surface of disc white, but darker at margins of pectorals; pelvics white with dark blotches at axils, on tip of anterior lobe and at anterior end of vent; tail greyish-brown becoming mottled with white posteriorly.

Raja dissimilis n.sp.

(Pl. 10 A, B; Figs 15 A, B, C)

Types

The holotype, a mature male (640 mm total length), trawled west of Cape Town by R.V. *Walther Herwig* (Station No. WH 194/67: 33°47′S, 17°14′E) in 1 000 metres, in the collection of the Institut für Seefischerei, Hamburg. Two paratypes, females (424·5 mm, 501 mm total length), taken at the same locality, in the collection in Hamburg.

Material

The type and paratypes.

R. dissimilis is unique among the southern Atlantic skates in that it shows a marked reduction in size, to eventual loss, of mid-dorsal thorns from the disc to the tail. In this respect and in tooth count, it resembles *R. senta* from the northern Atlantic, but may be distinguished from this species in that lateral rows of thorns are present on the disc and tail, and that it lacks the pale cross-barring of the tail which is typical of *R. senta* (Bigelow & Schroeder, 1953). In *R. dissimilis*, the ventral surface of the tail, from about the posterior edge of the pelvics to about the origin of the first dorsal fin, is a uniform grey colour, the tip of the tail being pale white. This peculiar tail coloration may result in confusion with *R. griseocauda* from the Patagonian–Falkland region, but in this species the tooth count is lower (30–36 rows in upper jaw in *R. griseocauda* (Norman, 1937); 37–41 rows in *R. dissimilis*) and there are major differences in ocular, scapular and caudal spination.

In morphometric dimensions, *R. dissimilis* approximates to *R. leopardus*, but it differs from this species in its lower tooth count (52–70 rows in upper jaw in *R. leopardus*), its peculiar caudal spination and in ventral coloration. Its identity is confirmed by its higher vertebral count (*R. dissimilis* Vtr 29–30; Vprd 65–69; VΣ 94–99; *R. leopardus* Vtr 31–33; Vprd 55–58; VΣ 88–90) and by the presence of two well-defined slits in the inner dorsal border of the clasper glans. By these facts, *R. dissimilis* is also distinguished from *R. confundens*, which has a similar tooth count. In *R. confundens* the vertebral count is lower (Vtr 28–30; Vprd 55–63; VΣ 84–92), and there is no distinct proximal slit in the glans. Furthermore, the snout in *R. dissimilis* is comparatively longer and the spination of the tail much less heavy than in *R. confundens*.

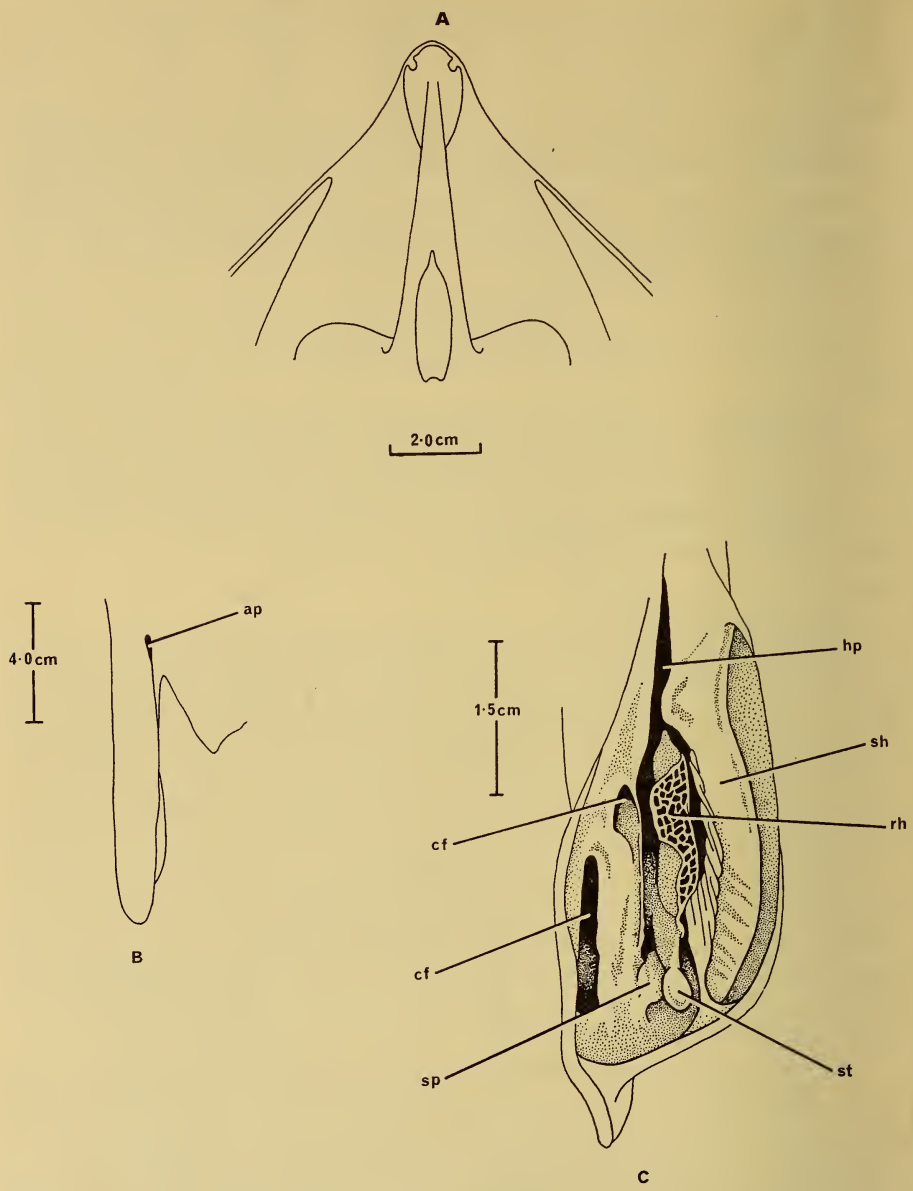


Fig. 15. *Raja dissimilis*.

A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; rh—rhipidion; hp—hypopyle; sh—shield; sp—spike; st—sentinel.

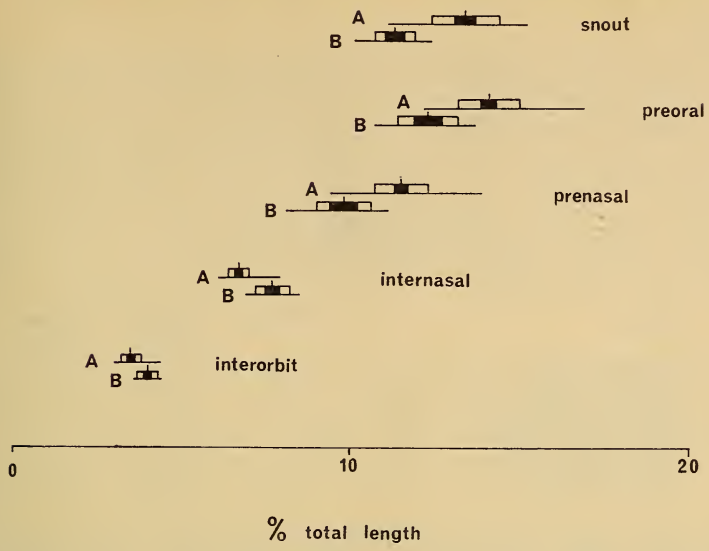


FIG. 16.

Comparison of cranial measurements of *R. confundens* and *R. leopardus* after the method of Hubbs & Hubbs (1953). In each diagram the base line represents the range of the measurement, the vertical line represents the mean, the open area represents the standard deviation on each side of the mean, and the solid area represents two standard errors on either side of the mean.

A—*Raja leopardus* B—*Raja confundens*

TABLE 14. *R. dissimilis*. Measurements expressed as permillage of the total length.

Character	*Type*	*Paratype* (501 *mm*)	*Paratype* (424·5 *mm*)
Total length	1 000	1 000	1 000
Disc width	609	571	593
Disc length	495	503	516
Snout to greatest disc width	308	318	312
Snout to middle of vent	506	485	502
Middle of vent to 1st dorsal origin	387	395	413
Snout length	136	143	151
Preoral length	138	150	161
Prenasal length	117	126	141
Eye: longitudinal diameter	35	39	40
Eye and spiracle	47	46	51
Interorbital distance	33	31	36
Interspiracular distance	67	66	75
Internasal distance	84	80	85
Mouth width	87	71	80
Gill slit lengths: 1st	14	14	13
3rd	19	16	16
5th	12	13	10
Distance between inner ends of gill slits:			
1st	139	140	141
5th	88	86	94
1st dorsal fin: height	31	19	31
base length	50	52	45
2nd dorsal fin: height	28	28	26
base length	43	51	41
Interdorsal space	0	0	0

Description

Disc about 1·1–1·2 times as broad as long, its width 1·6–1·8 in total length; sharp-pointed in front with anterior angle in front of spiracles 88°–93°; anterior margins concave just behind tip of snout and again at level of spiracles, more so in adults than in juveniles; outer and posterior angles broadly rounded. Axis of greatest breadth 1·5–1·7 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior half; its length from middle of vent to origin of first dorsal fin 1·2–1·3 in length from middle of vent to tip of snout.

Spination	*Holotype*	*Paratype* (424·5 *mm*)	*Paratype* (501 *mm*)
Preorbital thorns	7/8	2/1	4/4
Postorbital thorns	2/5	2/2	3/2
Supraspiracular thorns	1/1	1/1	1/1
Interspiracular thorns	1/1	1/1	1/1
Median nuchal thorns	1/2	1/1	2/3
Scapular thorns	0/0	3/3	2/2

A series of 20–32 thorns on mid-line of back and tail extending from about nuchal region almost to first dorsal origin in juveniles, but only extending three-quarters of tail length in adults. Median series flanked on each side on tail (juveniles) and on back and tail (adults) by a row of 16–35/17–38 thorns. Thorns along mid-dorsal region of back and tail becoming smaller and more widely-spaced posteriorly, until in larger specimens, thorns indistinguishable from spinules in region in front of first dorsal origin. Juveniles with spinules over whole of disc and tail, no large thorns on rostral cartilage; adults with spinules on interorbit and on tail, otherwise naked, except for 2 rostral thorns. Ventral surface of disc and tail smooth.

Snout pointed and a little produced; its length in front of orbits 4·1–4·6 times as long as distance between orbits; its length in front of mouth 1·7–1·9 times as great as distance between nostrils. Distance between orbits 1·1–1·3 in length of orbit. Rostral cartilage extending from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectoral fins falling short of rostral appendices.

Mouth slightly arched, more so in adults than in juveniles; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 37–41 rows in upper jaw, blunt and flat in females, sharp-pointed in adult males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals more or less similar in size and shape; first dorsal continuous with second.

Vertebral count:	*Holotype*	*Paratype* (424·5 *mm*)	*Paratype* (501 *mm*)
Vtr	31	29	30
Vprd	67	65	69
VΣ	98	94	99

Colour

Upper surface of disc and tail uniformly dark grey, tail mottled with white posteriorly. Ventral surface pale, posterior margins of pectorals and pelvics dark grey. Ventral surface of tail uniformly grey, becoming mottled with white posteriorly; region below dorsal fins white.

Raja confundens n.sp.

(Pl. 11 A, B; Figs 17 A, B, C)

? *Raja barnardi:* Krefft, 1968*a*: 61, pls IIIc, IV.

Types

The holotype, a juvenile male (378 mm total length), trawled off Cape Columbine in 620 metres, in the collection of the South African Museum (SAM 24411). The paratype, a male (478 mm total length), taken east of Cape Point in 660 metres, in the same collection (SAM 24479).

Material

22 specimens of both sexes (363–677 mm total length) including the holotype and paratype, trawled between Walvis Bay and east of Cape Point in 350–660 metres. Only 2 specimens preserved in the collection of the South African Museum (SAM 24480, PN 3), the others discarded at sea.

10 specimens trawled by R.V. *Walther Herwig* in 200–500 metres between Hondeklip Bay and Cape Frio also examined. These specimens in the collection of the Institut für Seefischerei, Hamburg.

R. confundens closely resembles the common South African west coast species *R. leopardus*, with which it is taken in trawls, but it may easily be distinguished from this species by its heavier spination pattern, particularly on the tail, and by its lower tooth count. The head in *R. confundens* is shorter and broader than in *R. leopardus* (cf. tables 15 and 16). These differences have been plotted graphically, according to the method of Hubbs & Hubbs (1953) and as there are no overlaps of standard deviations (except interorbit) the differences are significant (fig. 16). Furthermore, although the precaudal vertebral count is similar in the two species, there is a small difference in the range of trunk vertebrae. The identity of *R. confundens* is confirmed by its clasper structure.

The species identified as *R. barnardi* by Norman (1935) was distinguished from *R. leopardus* on the basis of a lower tooth count (40–42 rows in the upper jaw), which corresponds to that of *R. confundens*, and because of a single row of thorns along the back and tail. Krefft (1968*a*) on re-examination of the type of *R. barnardi* has shown that there are more than 50 rows of teeth in the upper jaw, while scattered lateral thorns in the juvenile type suggest the formation of lateral rows in the adult. There is no significant difference in tooth count, spination, vertebral count and proportional dimensions between *R. barnardi* and *R. leopardus*, and it is therefore held that these two species are synonymous.

Krefft (1968*a*) has referred four specimens obtained in the tropical east Atlantic by the *Galathea* and *Atlantide* expeditions to *R. barnardi*. These specimens are smaller than the type of *R. barnardi*, and yet possess a heavier spination

pattern and a lower tooth count. Examination of the proportional measurements and vertebral counts, suggests that these specimens should rather be referred to *R. confundens*.

The strongly re-curved thorns along the back and tail may cause *R. confundens* to be identified with *R. caudaspinosa*, but it differs markedly from this species in tail length and in tooth count.

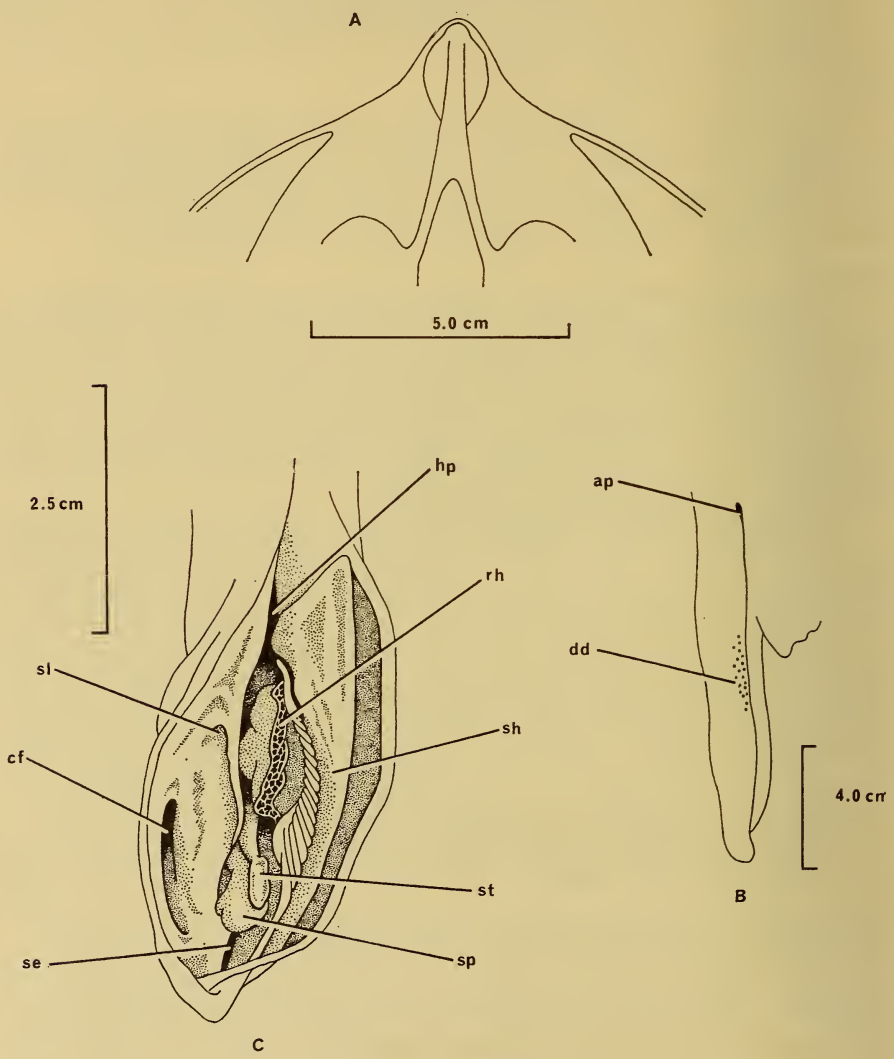


FIG. 17. *Raja confundens*.
A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; rh—rhipidion; se—sentina; sh—shield; sl—slit; sp—spike; st—sentinel.

TABLE 15. *R. confundens*. Measurements expressed as permillage of the total length. Number of specimens in the range 20.

Character	*Type*	*Paratype*	*Range*
Total length	1 000	1 000	
Disc width	595	596	558–668
Disc length	487	459	442–529
Snout to greatest disc width	320	280	280–340
Snout to middle of vent	444	441	444–521
Middle of vent to 1st dorsal origin	413	397	360–413
Snout length	124	107	101–124
Preoral length	136	118	107–137
Prenasal length	111	94	81–111
Eye: longitudinal diameter	37	37	36–47
Eye and spiracle	50	51	46–60
Spiracle	25	20	20–28
Interorbital distance	36	36	36–44
Interspiracular distance	61	63	57–74
Internasal distance	69	75	69–85
Mouth width	69	69	69–95
Gill slit lengths: 1st	18	17	14–24
3rd	19	18	15–25
5th	14	10	10–15
Distance between inner ends of gill slits:			
1st	148	154	148–170
5th	82	86	82–101
1st dorsal fin: height	29	23	24–44
base length	60	75	44–61
2nd dorsal fin: height	32	22	19–38
base length	60	69	41–61
Interdorsal space	0	0	0–12

Description

The figures in parentheses refer to the range of variation for 20 specimens, not including the type and paratype.

Disc about 1·2–1·3 (1·2–1·3) times as broad as long, its width 1·5–1·7 (1·5–1·8) in total length; obtuse in front, with anterior angle in front of spiracles 100° (99°–120°); anterior margins weakly concave just behind tip of snout; outer angles broadly rounded, posterior margins evenly convex. Axis of greatest breadth 1·6–1·9 (1·4–1·8) times as far from tip of snout as from posterior edge of disc. Tail with lateral folds along posterior third; its length from middle of vent to origin of first dorsal fin 1·1 (1·1–1·4) in length from middle of vent to tip of snout.

Spination	*Holotype*	*Paratype*	*Range*
Circumorbital thorns	6/6	6/6	5/6–10/10
Supraspiracular thorns	1/1	1/1	1/1–1/2
Interspiracular thorns	1/1	1/2	1/1–2/2
Median nuchal thorns	4	5	2–9
Lateral nuchal thorns	2/1	4+1/3	1/2–5+2/3+5
Scapular thorns	2/2	2/2	2/2–3/3

A row of 18–21 (17–24) thorns along mid-line of back and tail, from about nuchal region or just posterior to nuchal region to origin of first dorsal. Mid-dorsal thorns flanked on each side by a single row of larger, recurved thorns,

extending almost to first dorsal; smaller hooked spines situated laterally on tail from about axils of pelvics to about half tail length; smaller flattened asperities scattered laterally over tail. Stellate-based thorns on rostral cartilage and along anterior margins of disc to outer angles. Some specimens with a patch of spines on each posterior angle of disc. Ventral surface of disc and tail smooth.

With increasing size, spination pattern becomes heavier and more complex, so that 3 rows of thorns extend from nuchal region to origin of first dorsal and a further row of semi-lateral thorns is developed on the tail, making 5 rows in this region.

Snout rounded and not produced; its length in front of orbits 3·0–3·4 (2·5–3·3) times as long as distance between orbits; its length in front of mouth 1·6–1·9 (1·4–2·0) times as great as distance between nostrils. Orbits 1·5–1·8 (1·1–2·0) times as long as spiracles; distance between orbits 1·0 (0·9–1·4) as great as length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; tips of pectoral rays falling short of rostral appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 44 rows in upper jaw (39–45), broad and flat in females and juveniles, but sharp-pointed in mature males.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First and second dorsals confluent, sometimes with a small interdorsal space; second dorsal about equal in size to first.

Vertebral count: Vtr 28–30; Vprd 55–63; VΣ 84–92.

Colour

Dorsal surface of disc and tail uniformly dark grey. Ventral surface with irregular darker patches along posterior margins of pectorals and pelvics, about vent and along tail.

Raja leopardus Von Bonde & Swart, 1923

(Pl. 12 A; Figs 18 A, B, C)

Raia leopardus Von Bonde & Swart, 1923: 7, pl. 20, fig. 2. Barnard, 1925: 74. Smith, 1961: 67, fig. 73.
Raja leopardus: Norman, 1935: 44. Fowler, 1941: 390.
Raja barnardi Norman, 1935: 43, fig. 14; Fowler, 1941: 371.
Raia quadrimaculata (*non* Risso) Von Bonde & Swart, 1923: 5. Barnard, 1925: 70, pl. 4, fig. 5.
Raia lintea (*non* Fries) Barnard, 1925: 72.
Raia naevus (*non* Müller & Henle) Barnard, 1925: 72.

Types

The holotype of *R. leopardus* (247 mm total length), taken in 73 metres off the coast of Natal, formerly in the collection of the Government Marine Survey; now missing. Two juvenile specimens labelled 'cotype' in the collection of the British Museum (Natural History).

The holotype of *R. barnardi*, a juvenile male (375 mm total length), trawled by the *Discovery* off the west coast of the Cape Peninsula (34°00′S, 17°58′E) in 173–210 metres, in the collection of the British Museum (Natural History).

Material

70 specimens of both sexes (269–957 mm total length) trawled from WNW Lüderitzbucht to east of Cape Point in 300–660 metres. 26 specimens preserved

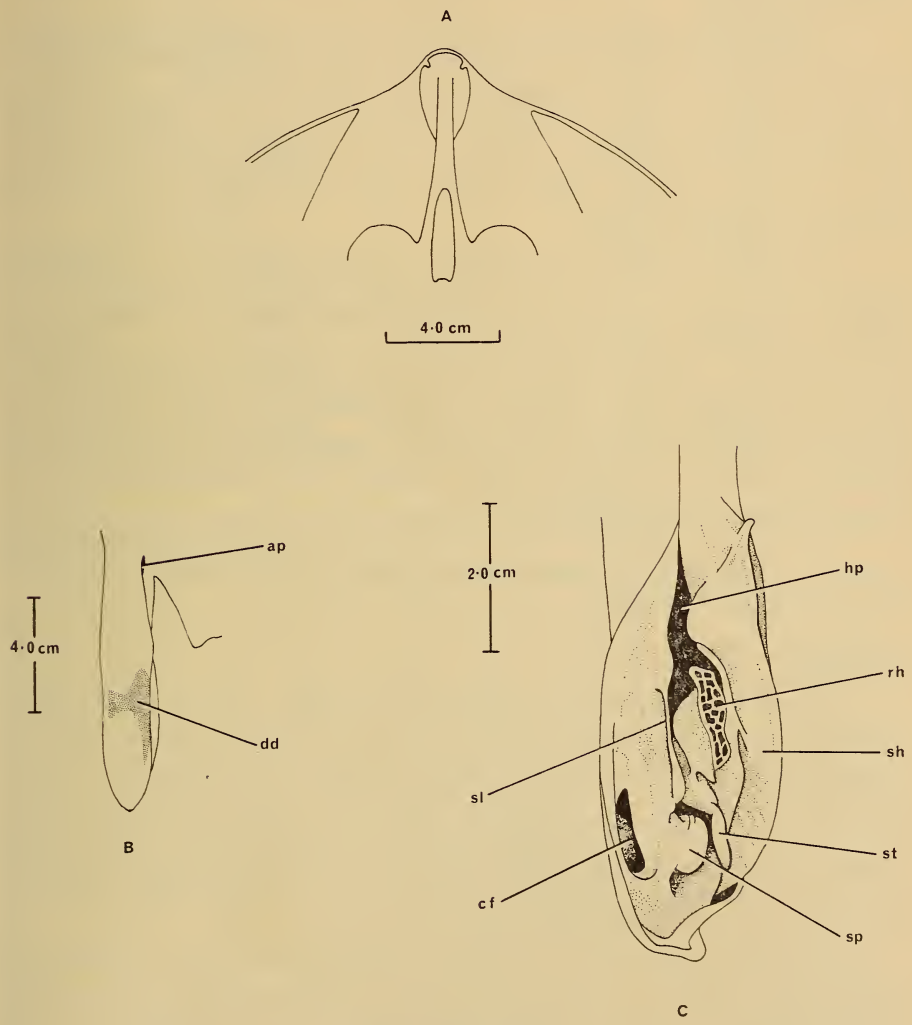


Fig. 18. *Raja leopardus*.
A: rostral bar and rostral appendices.
B: external view of right clasper from the dorsal side.
C: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; rh—rhipidion; sh—shield; sl—slit; sp—spike; st—sentinel.

in the collection of the South African Museum (SAM 22478, 24341, 24421–2, 24453–5, 24475–7, 24481–4, 24486–92).

R. leopardus is the commonest skate taken by commercial trawlers on the west coast of South Africa. It so closely resembles *R. wallacei* in external form, that it is difficult to distinguish between the two on the basis of measurement alone. However, there appears to be differences in the structure of the clasper glans and in the precaudal vertebral count, but the two species may yet prove to be synonymous.

R. leopardus has previously been confused with the North Atlantic species *R. naevus* and *R. lintea*. Norman (1935) has pointed out the differences between *R. leopardus* and *R. naevus*. *R. leopardus* may be distinguished from *R. lintea* by having three rows of thorns along the mid-dorsal region of the back, in which the thorns in the median row on the tail are the smallest. In *R. lintea* there is always one row of spines along the back, while the median row on the tail always has the largest thorns.

The species identified as *R. barnardi* by Norman (1935) was distinguished from *R. leopardus* on the basis of a lower tooth count and the presence of a single row of spines along the back and tail. Krefft (1968*a*) on re-examination of the type of *R. barnardi* has found that there are more than 50 rows of teeth in the upper jaw, while the presence of scattered lateral thorns on the tail of the juvenile type suggests the formation of lateral rows in the adult. There is no significant difference in tooth count, spination, vertebral count and proportional dimensions between *R. leopardus* and *R. barnardi*, and it is therefore held that the two species are synonymous.

It should be noted that the specimens identified as *R. barnardi* by Wallace (1967) do not follow the type description for that species, and have been referred to a new species *R. wallacei*.

Description

Disc about 1·1–1·3 times as broad as long, its width 1·5–1·7 in total length; obtuse in front, with anterior angle in front of spiracles 100–110°; anterior margins concave just behind tip of snout and again at level of spiracles, more so in adult males than in females and juveniles; outer and posterior angles broadly rounded. Axis of greatest breadth 1·4–1·9 times as far from tip of snout as from posterior edge of disc. Tail with moderately wide lateral folds on posterior third; its length from middle of vent to origin of first dorsal fin 1·1–1·5 in length from middle of vent to tip of snout.

Juvenile specimens with 4–5 thorns around inner margin of orbit; 0–1 thorn above spiracles; 1 pair small thorns between spiracles; 3–5 median nuchal thorns; 1–2 scapular thorns. A row of 25–30 thorns along mid-line of back and tail from nuchal region to origin of first dorsal fin. No interdorsal thorns. Usually 3–6 small thorns situated semi-laterally on each side of tail at about level of pelvics; remainder of tail with small fine spinules. Dorsal surface with spines on tip of snout and anterior margins of disc to level of spiracles,

TABLE 16. *R. leopardus*. Measurements expressed as permillage of the total length. Number of specimens 70.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	620	571–692
Disc length	510	481–543
Snout to greatest disc width	313	278–343
Snout to middle of vent	490	435–553
Middle of vent to 1st dorsal origin	374	336–419
Snout length	134	111–152
Preoral length	141	122–169
Prenasal length	115	94–139
Eye: longitudinal diameter	36	28–34
Eye and spiracle	50	46–56
Spiracle	22	17–34
Interorbital distance	35	30–44
Interspiracular distance	60	48–69
Internasal distance	67	61–79
Mouth width	75	56–93
Gill slit lengths: 1st	14	11–24
3rd	16	13–23
5th	11	7–21
Distance between inner ends of gill slits:		
1st	147	135–176
5th	84	61–110
1st dorsal fin: height	29	21–44
base length	54	41–65
2nd dorsal fin: height	29	21–41
base length	53	44–67
Interdorsal space	0	0–18

and wider spaced asperites over remainder of disc and pelvics. Ventral surface with spines on tip of snout.

Older specimens with 5–13 thorns around inner margin of each orbit and above spiracles; 1–2 pairs small inter-spiracular thorns; 4–9 median nuchal thorns, usually with 1–2 lateral rows forming a triangular patch; 2–3 scapular thorns. A median series of 19–29 widely-spaced thorns along the back and tail to origin of first dorsal, becoming reduced in size posteriorly and flanked on each side by 1 row thorns along back and 2–3 rows on tail; lateral and semi-lateral rows of thorns not greatly enlarged. Dorsal surface of disc with spines on snout, anterior margins of pectorals and sides of tail. Ventral surface with spines on tip of snout and along anterior margins.

Snout slightly pointed but not produced; its length in front of orbits 2·8–4·4 times as long as distance between orbits; its length in front of mouth 1·5–2·3 times as great as distance between nostrils. Orbits 1·0–2·1 times as long as spiracles; distance between orbits 0·9–1·4 times as great as length of orbit. Rostral cartilage projecting from cranium as hard bar with rostral appendices fused to bar throughout their length; anterior rays of pectoral fins falling short of rostral appendices.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 52–70 rows in upper jaw, with large posterior cusp in males, but blunt and flat in juveniles and females.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin. First and second dorsals confluent, sometimes with a small interdorsal space; second dorsal usually slightly smaller than first.

Vertebral count: Vtr 31–33; Vprd 55–58; VΣ 88–90.

Colour

Dorsal surface of disc uniformly brown to grey, sometimes with numerous dark spots, especially in juveniles. Norman (1935) reports the presence of a *naevus*-like ocellus at the base of each pectoral fin, particularly in adults. Ventral surface uniformly pale or with irregularly arranged darker blotches and patches on pectorals and pelvics.

Raja wallacei n.sp.

(Pl. 12 B; Figs 19 A, B)

Raja barnardi (*non* Norman) Wallace, 1967: 39, figs 20, 21.

Type

The holotype of *R. wallacei*, an adult male (842 mm total length), trawled at 34°10′S, 17°45′E in 292 metres, in the collection of the Oceanographic Research Institute, Durban. The paratype, a female (489 mm total length)

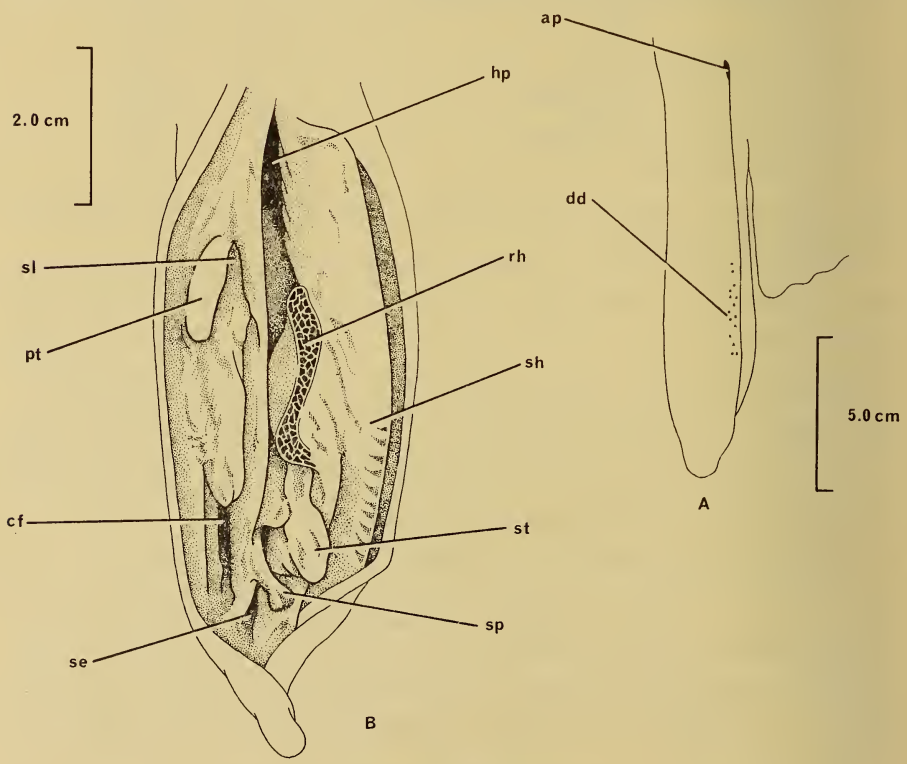


FIG. 19. *Raja wallacei*.

A: external view of right clasper from the dorsal side.

B: lateral view of right clasper, opened to show structural features of the clasper glans.

ap—apopyle; cf—cleft; dd—dermal denticles; hp—hypopyle; pt—promontory; rh—rhipidion; se—sentina; sh—shield; sl—slit; sp—spike; st—sentinel.

taken SE Durban Bluff also in the same collection.

Material

The holotype and paratype. Wallace (1967) has examined 20 specimens.

Wallace (1967) confused this species with *R. barnardi*, which was taken at the same locality. Comparison of the types of *R. wallacei* with *R. barnardi* has revealed that in *R. wallacei* the precaudal vertebral count is higher, the snout shorter, the interorbital distance greater than in *R. barnardi*. It should be noted *R. barnardi* is now held to be synonymous with *R. leopardus*.

R. wallacei closely resembles the common west coast skate *R. leopardus*, but may be distinguished from it by its greater number of precaudal vertebrae. Furthermore there are slight differences in the structure of the clasper glans. So closely are these two species related, however, that on the basis of measurement alone it is difficult to separate the one from the other. They may yet prove to be synonymous. *R. wallacei* seems to be characterized by the presence of dark blotches on the tip of each pelvic fin.

Although the holotype of *R. wallacei* was taken in Cape waters, the present author has not recorded this species during the survey. The species would seem to occur along the whole of the coastal region from the Cape to north of the Limpopo River mouth (Wallace, 1967).

TABLE 17. *R. wallacei*. Measurements expressed as permillage of the total length.

Character	*Type* (B 155)	*Paratype* (B 126)
Total length	1 000	1 000
Disc width	625	557
Disc length	494	466
Snout to greatest disc width	289	286
Snout to middle of vent	472	448
Middle of vent to 1st dorsal origin	400	413
Snout length	96	112
Preoral length	102	124
Prenasal length	73	99
Eye: longitudinal diameter	36	40
Eye and spiracle	55	56
Spiracle	25	21
Interorbital distance	42	37
Interspiracular distance	62	62
Internasal distance	69	70
Mouth width	82	76
Gill slit lengths: 1st	20	14
3rd	22	17
5th	15	13
Distance between inner ends of gill slits:		
1st	158	142
5th	88	86
1st dorsal fin: height	37	29
base length	53	61
2nd dorsal fin: height	27	27
base length	51	57
Interdorsal space	20	2

Description

Disc about 1·2–1·3 times as broad as long, its width 1·6–1·8 in total length; obtuse in front with maximum angle in front of spiracles about 110°; anterior margins concave just behind tip of snout and again at level of spiracles; outer and posterior angles broadly rounded, posterior margins slightly convex. Axis of greatest breadth 1·4–1·6 times as far from tip of snout as from posterior edge of disc. Tail with narrow lateral folds; its length from middle of vent to origin of first dorsal fin 1·1–1·2 in length from middle of vent to tip of snout; its length from middle of vent to tip of tail 1·1–1·3 times as long as distance from middle of vent to tip of snout.

Spination	*Holotype*	*Paratype*
Circumorbital thorns	8/10	7/8
Supraspiracular thorns	2/3	2/3
Interspiracular thorns	0/0	1/1
Median nuchal thorns	1	7
Lateral nuchal thorns	1/1	4/4
Scapular thorns	0/0	1/2

No median row of thorns in holotype, but paratype with 34 thorns along mid-line of back and tail from about nuchal region to first dorsal origin; no thorns in dorsal interspace. Median row (or mid-line) flanked on each side by a single row of thorns from about nuchal region to axils of pelvics, increasing to two rows on each side from axils to level of interdorsal space. Dorsal surface with spines on tip of snout, along anterior margins of disc to outer angles, and on tail. Ventral surface with spinules on tip of snout and anterior margins of disc to level of mouth. Otherwise smooth.

Snout not produced, but with short terminal projection; its length in front of orbits 2·3–3·1 times as long as distance between orbits; its length in front of mouth 1·5–1·8 times as great as distance between nostrils. Orbits 1·5–1·9 times as long as spiracles; distance between orbits 0·9–1·2 times as great as length of orbit.

Mouth slightly arched; nasal curtain fringed; expanded posterior margin of nostril heavily fringed. Teeth arranged in 59–67 regular rows in upper jaw, with round bases and sharp posterior cusp.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

First dorsal larger than second and separated from it by a small but definite space; interspace between dorsals about 39% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 70.

Colour

Upper surface uniformly brown with scattered, irregular lighter spots. *Naevus*-like ocellus at base of each pectoral. Lower surface pale, with a single, dark blotch on tip of anterior lobe of pelvic fin.

Bathyraja smithii (Müller & Henle, 1841)
(Pl. 13; Figs 20 A, B, C; 21 A, B)

Raja smithii Müller & Henle, 1841: 150, pl. 49, fig. 1. Gray, 1851: 112. Bleeker, 1860: 58. Duméril, 1865: 553. Günther, 1870: 467. Gilchrist, 1902: 168. Thompson, 1914: 159.
Raja smithi: Norman, 1935: 41. Fowler, 1941: 364.
Raia smithii: Garman, 1913: 366. Von Bonde & Swart, 1923: 5.
Raia smithi: Barnard, 1925: 66, pl. 4, fig. 4.
non Raia smithi: Smith, 1961: 66, *non* pl. 3, fig. 68 (= *C. parcomaculata*).
Raja eatonii Günther, 1876: 390; 1879: 166.
Raja eatoni Günther, 1880: 15.
Raia eatonii: Garman, 1913: 365.

Types

The holotype of *R. eatonii*, a male (26·5 in. (673 mm) total length), from Royal Sound, and holotype of *R. smithii*, a dried skin, from South Africa, in the British Museum (Natural History). A mature male specimen, labelled type of *R. smithii*, from the Bosphorus, in the Muséum National des Sciences Naturelles, Paris, does not belong to this species and should be referred to *R. clavata*.

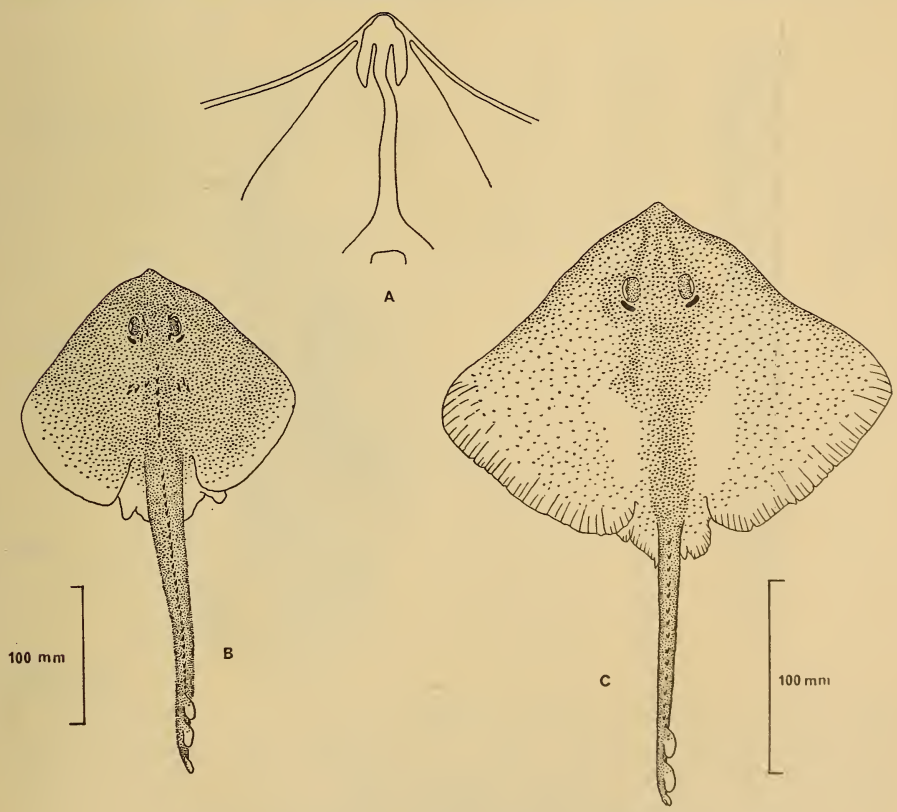


FIG. 20. *Bathyraja smithii*.
A: rostral bar and rostral appendices.
B, C: dorsal view of immature males, showing variation in spination.

Material

10 specimens of both sexes (309–1 141 mm total length), trawled east of Cape Point in 658–868 metres. 7 specimens preserved in the collection of the South African Museum (SAM 24473, 15666).

Although previously included in the genus *Raja*, this species should now be referred to the genus *Bathyraja* because of the nature of the rostral bar and rostral appendices, the number of precaudal vertebrae, and the lack of a shield in the clasper glans. Ishiyama & Hubbs (1968) also define the genus by the presence of a pseudosiphon in the clasper glans, but this is present in species of the *radiata*-group, and suggest that the genus *Bathyraja* is restricted to the Pacific. However, Dr. G. Krefft (personal communication) suggests that *Bathyraja* is a bipolar, antitropical genus.

B. smithii is most easily distinguished from all other known South African species by its low tooth count (less than 30 rows in the upper jaw) and by the lack of lateral rows of thorns on the tail. Adults resemble some specimens of *R. clavata* in shape, but differ in tooth count and spination. It should be noted

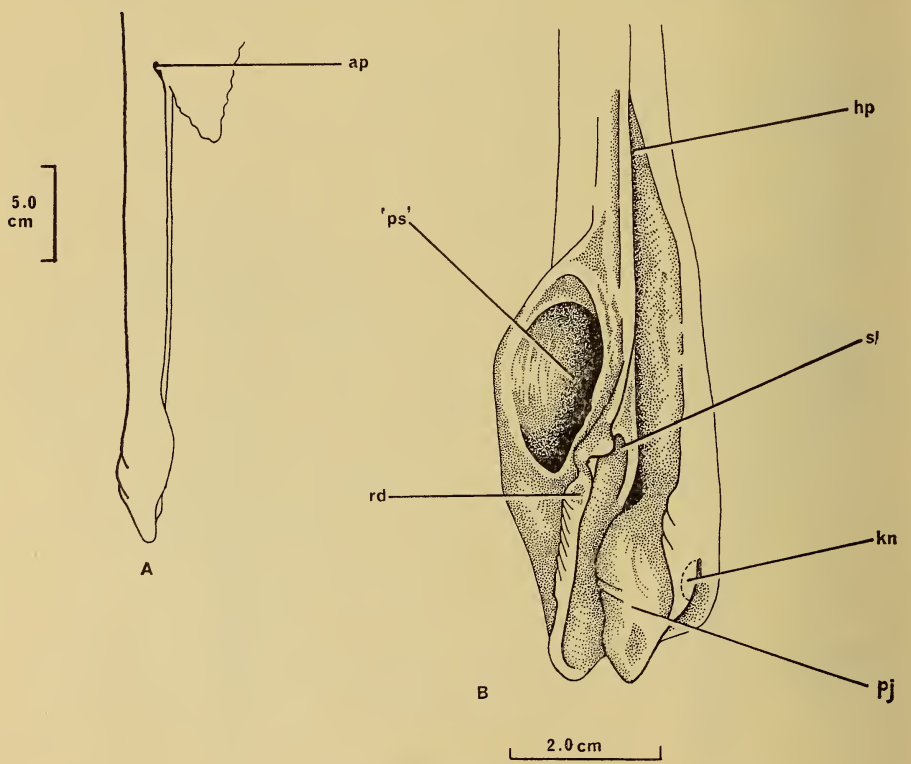


FIG. 21. *Bathyraja smithii*.
A: external view of right clasper from the dorsal side.
B: lateral view of right clasper, opened to show structural features of the glans.
ap—apopyle; hp—hypopyle; kn—knife; pj—projection; rd—ridge; 'ps'—'pseudosiphon'; sl—slit.

that Wallace (1967) gives a tooth count of 23–26 rows for *R. clavata*. This is inconsistent with previous work and with the investigations of this paper.

The dorsal surface of the disc of *B. smithii* is devoid of large thorns, except in juvenile specimens, which resemble *R. spinacidermis*. However, *R. spinacidermis* has a higher tooth count. The smoky-black borders to the ventral margins of the pectoral and pelvic fins may lead to confusion with *R. alba*, but this species can easily be distinguished by its produced and pointed snout.

Although Günther (1879) and Garman (1913) consider *R. eatonii* to be closely allied to *B. smithii*, and Barnard (1925) regards *R. eatonii* as a sub-species, Norman (1935) holds the two to be distinct on the basis of differences in spination and because of a longer snout in *R. eatonii*. Preliminary external examination of the claspers of the type of *R. eatonii*, has led me to synonymise the two species, until an examination of the clasper cartilages can be made.

TABLE 18. *B. smithii*. Measurements expressed as permillage of the total length. Number of specimens 10.

Character	*Mean*	*Range*
Total length	1 000	
Disc width	708	680–745
Disc length	529	513–544
Snout to greatest disc width	324	302–338
Snout to middle of vent	517	498–543
Middle of vent to 1st dorsal origin	355	335–376
Snout length	121	97–134
Preoral length	115	105–131
Prenasal length	89	82–99
Eye: longitudinal diameter	33	29–47
Eye and spiracle	49	40–57
Spiracle	26	19–30
Interorbital distance	56	49–61
Interspiracular distance	79	75–84
Internasal distance	91	84–98
Mouth width	86	78–93
Gill slit lengths: 1st	14	12–18
3rd	16	13–17
5th	14	12–18
Distance between inner ends of gill slits:		
1st	180	171–190
5th	122	109–136
1st dorsal fin: height	21	14–29
base length	38	32–50
2nd dorsal fin: height	20	17–28
base length	36	28–44
Interdorsal space	14	7–22

Description

Disc about 1·3–1·4 times as broad as long, its width 1·3–1·5 in total length; obtuse in front, with anterior angle in front of spiracles 90°–100°: anterior margins weakly concave posterior to snout in juveniles, but more sinuous in adults and particularly concave at level of spiracles in mature males; posterior and outer angles broadly rounded. Axis of greatest breadth 1·2–1·7 times as far from tip of snout as from posterior edge of disc. Tail with moderately

TABLE 19. Location and collection numbers of South African rajid material.

Species	*Institution*	*Type*	*Coll. No.*
C. parcomaculata	B.M.(N.H.)	paratype	1935.7.14.1
R. albalinea	B.M.(N.H.)	paratype	1935.7.14.4
R. spinacidermis	B.M.(N.H.)	holotype	1935.7.19.7
R. ocellifera	B.M.(N.H.)	syntypes	1895.12.27.14
			1905.6.8.14
R. rhizacanthus	B.M.(N.H.)	holotype	1905.6.8.13
R. leopardus	B.M.(N.H.)	2 'cotypes'	1935.7.14.3
R. barnardi	B.M.(N.H.)	holotype	1935.5.2.65
B. smithii	B.M.(N.H.)	holotype	1953.8.10.1
B. eatonii	B.M.(N.H.)	holotype	1876.3.23.21
R. pullopunctata	J.L.B.S.	holotype	—
		paratype	—
C. triangularis	J.L.B.S.	holotype	—
		paratype	—
R. campbelli	O.R.I.	holotype	B 804
		paratype	B 859
R. wallacei	O.R.I.	holotype	B 155
		paratype	B 126
R. stenorynchus	O.R.I.	holotype	B 186
R. springeri	O.R.I.	holotype	B 909
		paratype	B 185
R. lanceorostrata	O.R.I.	holotype	B 869
		paratype	B 868
R. doutrei	M.N.H.N.	holotype	59, 41
R. capensis	M.N.H.N.	paratype	1333
R. straeleni	I.R.S.N.	holotype	I.G. 16808; 99
		20 paratypes	I.G. 16808; 100–107
R. robertsi	I.S.H.	holotype	54/67
R. ravidula	I.S.H.	holotype	50/67
		2 paratypes	47a, b/67
R. dissimilis	I.S.H.	holotype	46a/67
		2 paratypes	46b, c/67
R. confundens	S.A.M.	holotype	24411
		paratype	24479

B.M.(N.H.) — British Museum (Natural History), London.
J.L.B.S. — J.L.B. Smith Institute of Ichthyology, Grahamstown.
O.R.I. — Oceanographic Research Institute, Durban.
M.N.H.N. — Muséum National d'Histoire Naturelle, Paris.
I.R.S.N. — Institut Royal des Sciences Naturelles, Brussels.
I.S.H. — Institut für Seefischerei, Hamburg.
S.A.M. — South African Museum, Cape Town.

wide lateral folds; its length from middle of vent to origin of first dorsal fin 1·3–1·6 in length from middle of vent to tip of snout.

Juveniles with 1 thorn in front of orbit and 1–2 behind; 2 median nuchal spines; 3–4 scapular thorns; a row of about 30 thorns along mid-line of back and tail from nuchal region to first dorsal origin; 1 thorn in dorsal interspace. Entire upper surface of disc and tail with widely-spaced spinules. Ventral surface smooth.

Larger specimens with ocular, nuchal and scapular thorns absent; 14–19 large thorns along mid-line of tail from above vent to origin of first dorsal fin;

0–1 thorns in dorsal interspace. Dorsal surface of disc and tail spinulose, but no lateral rows of thorns on tail. Ventral surface smooth.

Snout obtuse; its length in front of orbits 2·0–2·6 times as long as distance between orbits; its length in front of mouth 1·1–1·4 times as great as distance between nostrils. Orbits 1·0–1·4 times as long as spiracles; distance between orbits 1·5–1·9 times as great as length of orbit.

Rostral cartilage elongate with delicate, slender bar, extending to tip of snout without a segment; rostral appendix attached to extremity of rostral bar on each side, with distal part free from lateral sides of rostral cartilage; radial cartilages of pectorals extending anteriorly almost to rostral appendices.

Mouth slightly arched; nasal curtain not fringed; expanded posterior margin of nostril heavily fringed. Teeth with a single large cusp, arranged in 24–28 regular rows in upper jaw.

Anterior lobes of pelvics fin-like and continuously connected with posterior lobes along outer margin of fin.

Dorsal fins similar in shape and about equal in size, with convex anterior margins and broadly rounded apices; interspace between dorsals 22–40% as long as base of first dorsal.

Number of precaudal vertebrae (Vprd) 68–71.

Colour

Dorsal surface more or less uniformly greyish or brownish in preserved specimens, sometimes with small white spots. Ventral surface white, with black blotches between gill slits and around vent; anterior margins of pectorals narrowly and posterior margins of pectorals and pelvics broadly coloured black; ventral surface of tail smoky- black.

Summary

This paper consists of a systematic revision at the species level of the Rajidae of the west and south coasts of southern Africa. Five new species are described, three of which are known only from deep water, while two species are recorded for the first time in the South Atlantic. Keys to the southern African rajid fauna are given.

Natural relationships between the species are evident, suggesting a regrouping of the *Raja* species at the generic or sub-generic level. The significance of these relationships will be dealt with in a later paper.

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A. *C. parcomaculata* (female). Dorsal view. Scale in cm and in. B. *R. doutrei* (male; claspers and tip of pelvic fins removed). Dorsal view. Scale in cm and in.

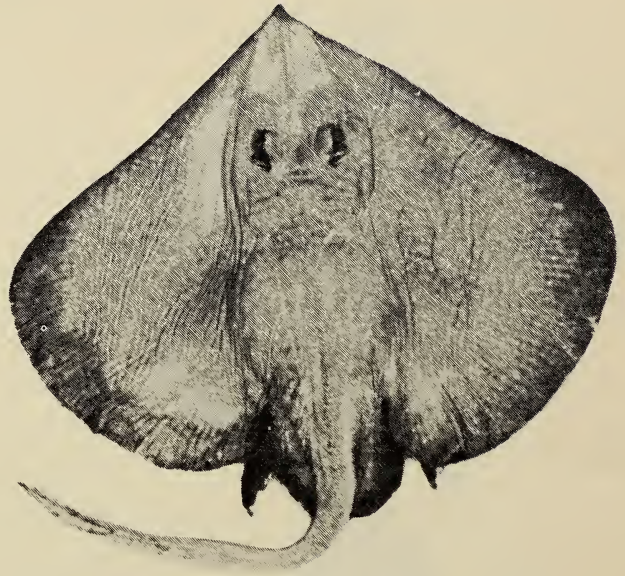
A. *R. pullopunctata* (juvenile male). Dorsal view. Scale in cm and in. B. *R. pullopunctata* (male; right pelvic fin and clasper removed). Dorsal view. Scale in cm and in.

A

B

A. *R. caudaspinosa* (male). Dorsal view. Scale in cm and in. B. *R. caudaspinosa* (female). Dorsal view. Scale in cm and in.

A



B

A.? *R. spinacidermis* (juvenile). Dorsal view. Scale in cm and in. B. *R. spinacidermis* (adolescent). Dorsal view.

A. *R. alba* (juvenile male). Dorsal view. Scale in cm and in. B. *R. alba* (male). Dorsal view. Scale in cm and in.

A. *R. clavata* (female). Dorsal view. Scale in cm and in. B. *R. braeleni* (male). Dorsal view.

A

B

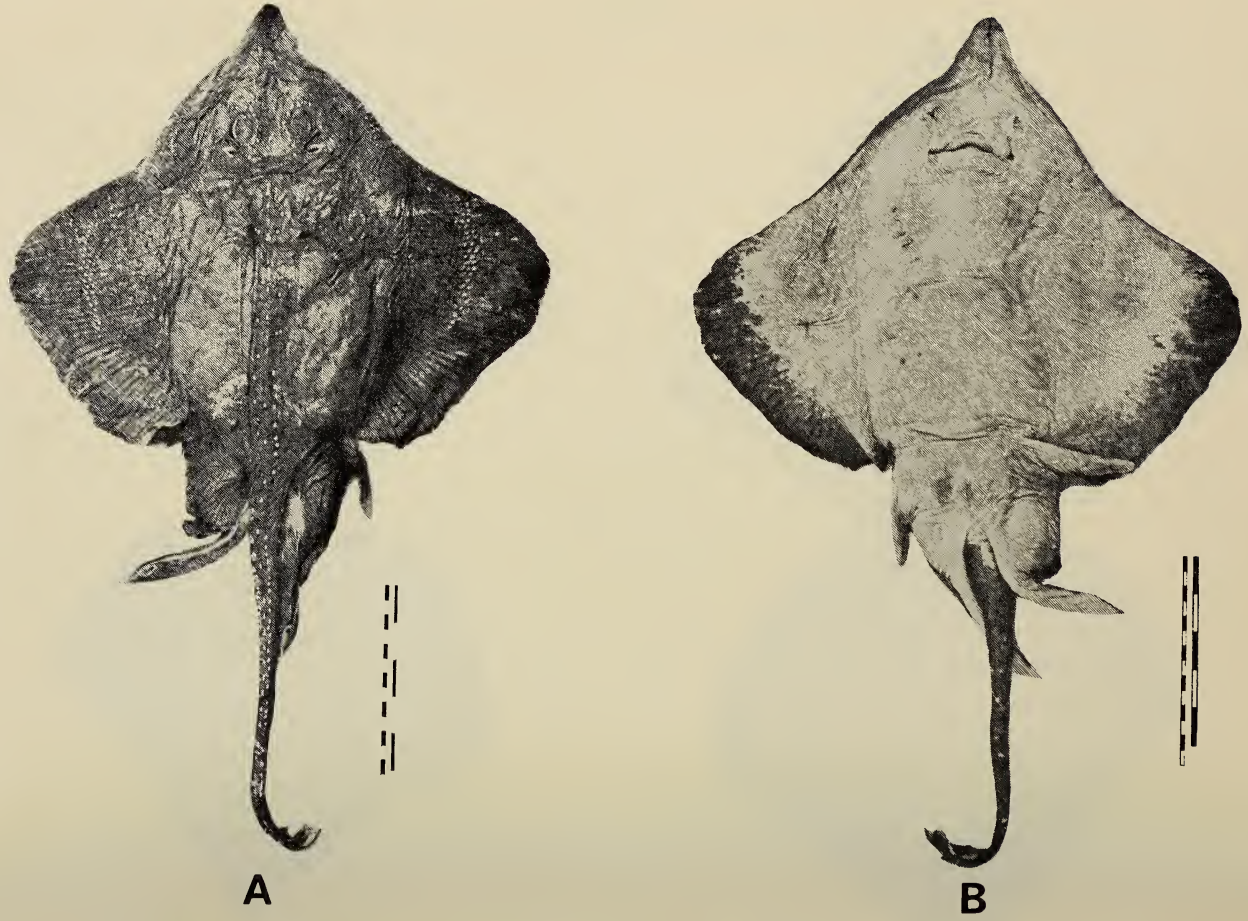
A. *R. radiata* (juvenile male). Dorsal view. Scale in cm and in. B. *R. miraletus* (female). Dorsal view. Scale in cm and in.

A

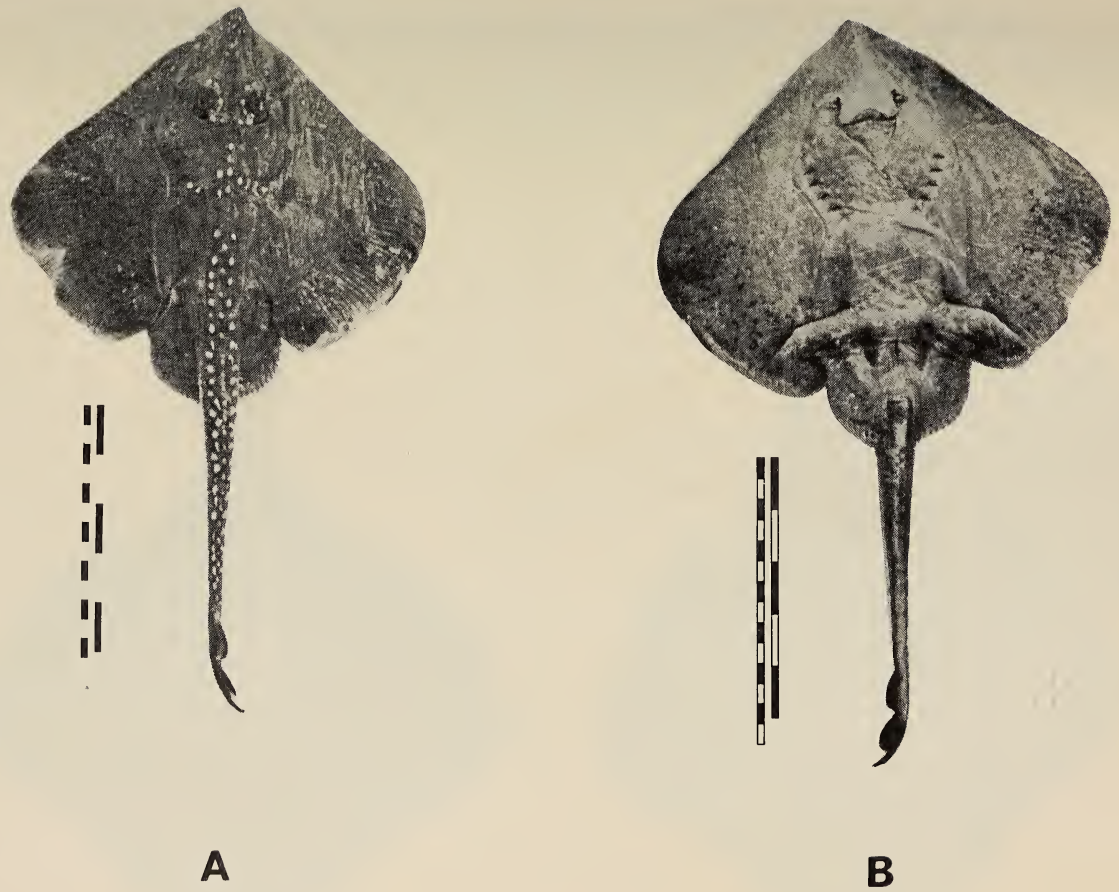
B

A. *R. robertsi*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. robertsi*, n. sp. TYPE. Ventral view. Scale in cm and in.

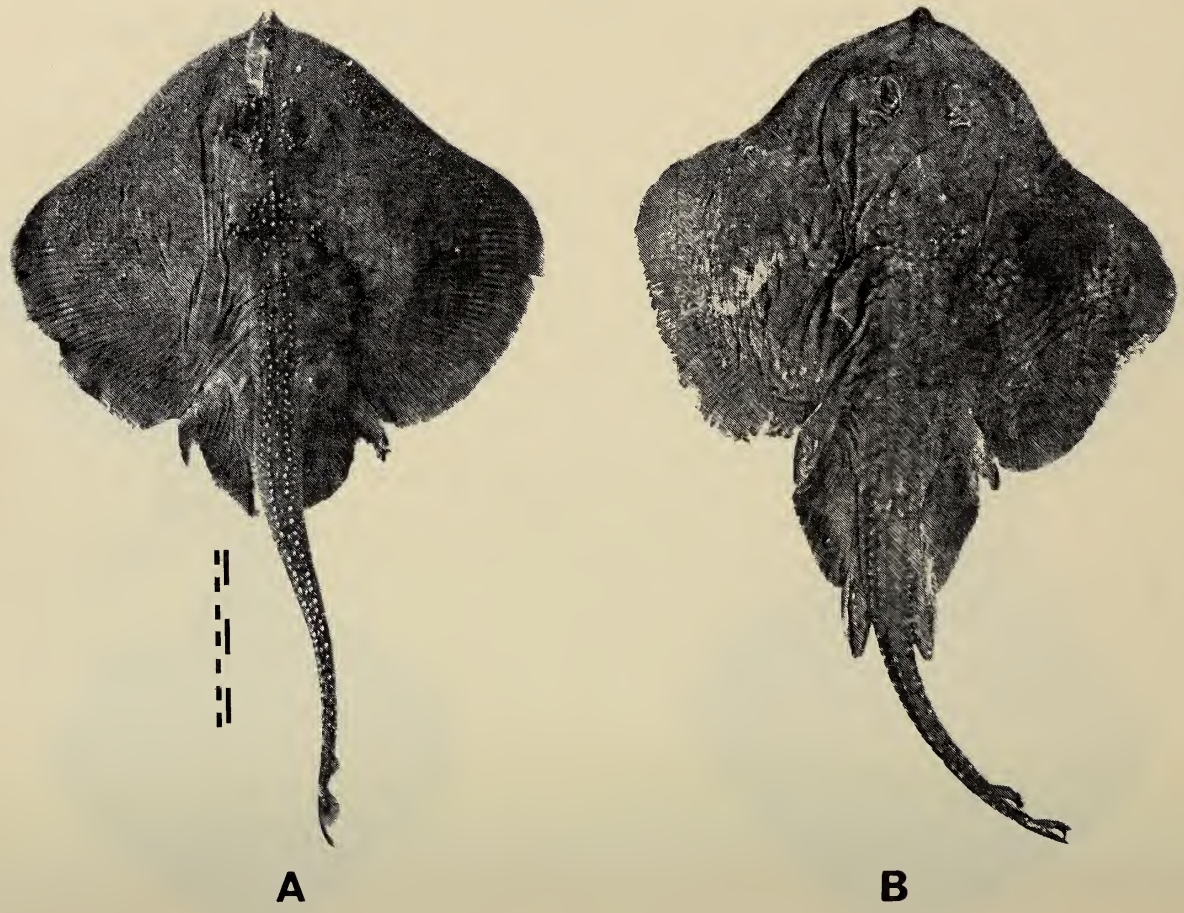
A. *R. ravidula*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. ravidula*, n. sp. TYPE. Ventral view. Scale in cm and in.



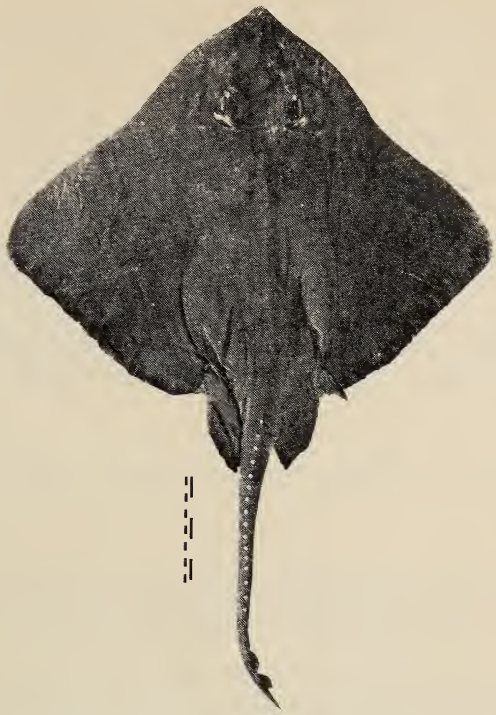
A. *R. dissimilis*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. dissimilis*, n. sp. TYPE. Ventral view. Scale in cm and in.



A. *R. confundens*, n. sp. TYPE. Dorsal view. Scale in cm and in. B. *R. confundens*, n. sp. TYPE. Ventral view. Scale in cm and in.



A. *R. leopardus* (female). Dorsal view. Scale in cm and in. B. *R. wallacei*, n. sp. TYPE. Dorsal view.



B. smithii (female). Dorsal view. Scale in cm and in.